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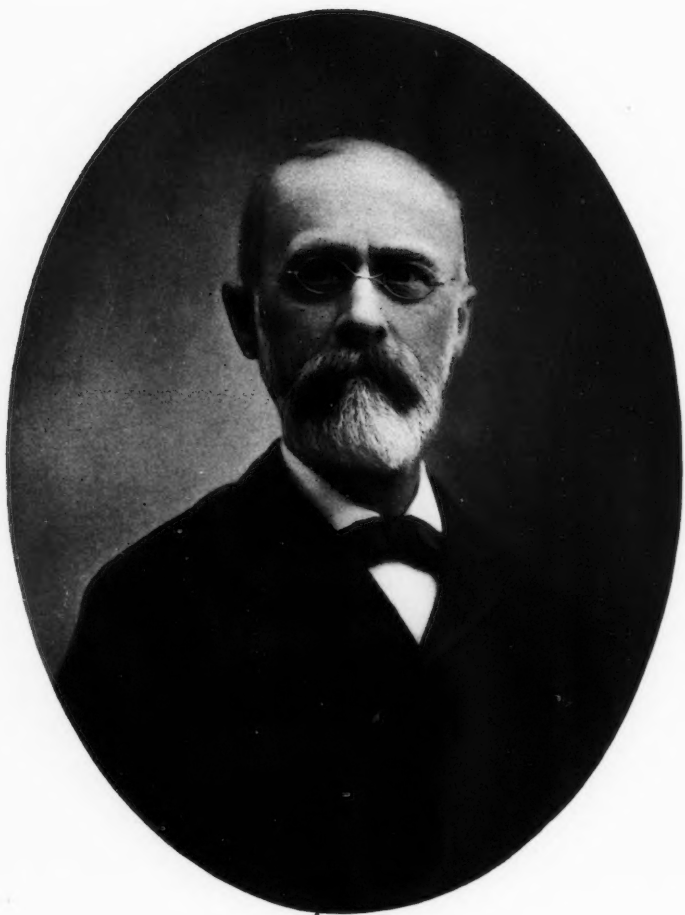
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TRANSACTIONS
OF THE
AMERICAN
FISHERIES
SOCIETY





CHARLES G. ATKINS

Pioneer American Fish Culturist

Commissioner of Fisheries of Maine 1862-1871

In U. S. Fisheries Service Continuously from July, 1872, to Date

Corresponding Secretary of American Fisheries Society 1904-1910

Born January 19, 1841





TRANSACTIONS
OF THE
AMERICAN
FISHERIES SOCIETY
AT ITS
FORTY-FIRST ANNUAL
MEETING



OCTOBER 3, 4, AND 5, 1911

AT

ST. LOUIS, MO.

WASHINGTON
PUBLISHED BY THE SOCIETY
1912

Officers

1910-1911

Elected at the Fortieth Anniversary Meeting in New York City for the following year, including the meeting held in St. Louis, Mo., October 3, 4, and 5, 1911.

President.....W. E. MEEHAN, Harrisburg, Pa.
Vice-President.....S. F. FULLERTON, St. Paul, Minn.
Recording Secretary.....WARD T. BOWER, Washington, D. C.
Assistant Recording Secretary...ETHEL M. SMITH, Washington, D. C.
Corresponding Secretary.....HUGH M. SMITH, Washington, D. C.
Treasurer.....C. W. WILLARD, Westerly, R. I.

Vice-Presidents of Divisions

Fish Culture.....CHARLES G. ATKINS, East Orland, Me.
Aquatic Biology and Physics.BARTON W. EVERMANN, Washington, D. C.
Commercial Fishing.....JOHN W. TITCOMB, Lyndonville, Vt.
Angling.....JOHN E. GUNCKEL, Toledo, Ohio
Protection and Legislation....THEODORE S. PALMER, Washington, D. C.

Executive Committee

CHARLES H. TOWNSEND, *Chairman*, New York City; GEO. T. MATHEWSON, Thompsonville, Conn.; JABE ALFORD, Madison, Wis.; HENRY B. WARD, Urbana, Ill.; DANIEL B. FEARING, Newport, R. I.; D. H. POWER, Suttons Bay, Mich.; JOHN P. BABCOCK, San Francisco, Cal.

1911-1912

Elected at the Forty-first Annual Meeting in St. Louis, Mo., for the ensuing year, including the meeting to be held in Denver, Colo., beginning September 3, 1912.

President.....S. F. FULLERTON, St. Paul, Minn.
Vice-President.....CHARLES H. TOWNSEND, New York City
Recording Secretary.....WARD T. BOWER, Washington, D. C.
Assistant Recording Secretary...ETHEL M. SMITH, Washington, D. C.
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Aquatic Biology and Physics.....DR. EDWIN LINTON, Washington, Pa.
Commercial Fishing.....A. B. ALEXANDER, Washington, D. C.
Angling.....H. WHEELER PERCE, Chicago, Ill.
Protection and Legislation.....DR. T. S. PALMER, Washington, D. C.

Executive Committee

DR. HENRY B. WARD, *Chairman*, Urbana, Ill.; DANIEL B. FEARING, Newport, R. I.; E. HART GEER, Hadlyme, Conn.; D. H. POWER, Suttons Bay, Mich.; A. R. WHITAKER, Phoenixville, Pa.; R. TYSON WHITE, Brooklyn, N. Y.; W. L. MAY, Denver, Colo.

AMERICAN FISHERIES SOCIETY

Organized 1870

The first meeting of the Society occurred December 20, 1870. The organization then effected continued until February, 1872, when the second meeting was held. Since that time there has been a meeting each year, as shown below. The respective presidents were elected at the meeting, at the place, and for the period shown opposite their names, but they presided at the subsequent meeting.

PRESIDENTS, TERMS OF SERVICE, AND PLACES OF MEETING

1. William Clift.....1870-1872....New York, N. Y.
2. William Clift.....1872-1873....Albany, N. Y.
3. William Clift.....1873-1874....New York, N. Y.
4. Robert B. Roosevelt..1874-1875....New York, N. Y.
5. Robert B. Roosevelt..1875-1876....New York, N. Y.
6. Robert B. Roosevelt..1876-1877*....New York, N. Y.
7. Robert B. Roosevelt..1877-1878....New York, N. Y.
8. Robert B. Roosevelt..1878-1879....New York, N. Y.
9. Robert B. Roosevelt..1879-1880....New York, N. Y.
10. Robert B. Roosevelt..1880-1881....New York, N. Y.
11. Robert B. Roosevelt..1881-1882....New York, N. Y.
12. George Shepard Page..1882-1883....New York, N. Y.
13. James Benckard.....1883-1884....New York, N. Y.
14. Theodore Lyman.....1884-1885....Washington, D. C.
15. Marshall McDonald...1885-1886....Washington, D. C.
16. W. M. Hudson.....1886-1887....Chicago, Ill.
17. William L. May.....1887-1888....Washington, D. C.
18. John H. Bissell.....1888-1889....Detroit, Mich.
19. Eugene G. Blackford..1889-1890....Philadelphia, Pa.
20. Eugene G. Blackford..1890-1891....Put-in Bay, Ohio.
21. James A. Henshall...1891-1892....Washington, D. C.
22. Herschel Whitaker...1892-1893....New York, N. Y.
23. Henry C. Ford.....1893-1894....Chicago, Ill.
24. William L. May.....1894-1895....Philadelphia, Pa.
25. L. D. Huntington....1895-1896....New York, N. Y.
26. Herschel Whitaker...1896-1897....New York, N. Y.
27. William L. May.....1897-1898....Detroit, Mich.
28. George F. Peabody...1898-1899....Omaha, Nebr.
29. John W. Titcomb....1899-1900....Niagara Falls, N. Y.
30. F. B. Dickerson.....1900-1901....Woods Hole, Mass.
31. E. E. Bryant.....1901-1902....Milwaukee, Wis.
32. George M. Bowers....1902-1903....Put-in Bay, Ohio.
33. Frank N. Clark.....1903-1904....Woods Hole, Mass.
34. Henry T. Root.....1904-1905....Atlantic City, N. J.
35. C. D. Joslyn.....1905-1906....White Sulphur Springs, W. Va.
36. E. A. Birge.....1906-1907....Grand Rapids, Mich.
37. Hugh M. Smith.....1907-1908....Erie, Pa.
38. Tarleton H. Bean....1908-1909....Washington, D. C.
39. Seymour Bower.....1909-1910....Toledo, Ohio.
40. William E. Meehan...1910-1911....New York, N. Y.
41. S. F. Fullerton.....1911-1912....St. Louis, Mo.

*A special meeting was held at the Centennial Grounds, Philadelphia, Pa., October 6 and 7, 1876.

CERTIFICATE OF INCORPORATION OF THE AMERICAN FISHERIES SOCIETY

We, the undersigned, persons of full age and citizenship of the United States, and a majority being citizens of the District of Columbia, pursuant to and in conformity with sections 599 to 603, inclusive, of the Code of Law for the District of Columbia enacted March 3, 1901, as amended by the Acts approved January 31 and June 30, 1902, hereby associate ourselves together as a society or body corporate and certify in writing:

1. That the name of the Society is the AMERICAN FISHERIES SOCIETY.

2. That the term for which it is organized is nine hundred and ninety-nine years.

3. That its particular business and objects are to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish; with power:

a. To acquire, hold and convey real estate and other property, and to establish general and special funds.

b. To hold meetings.

c. To publish and distribute documents.

d. To conduct lectures.

e. To conduct, endow, or assist investigation in any department of fishery and fish-culture science.

f. To acquire and maintain a library.

g. And, in general, to transact any business pertinent to a learned society.

4. That the affairs, funds and property of the corporation shall be in general charge of a council, consisting of the officers and the executive committee, the number of whose members for the first year shall be seventeen, all of whom shall be chosen from among the members of the Society.

Witness our hands and seals this 16th day of December, 1910.

SEYMOUR BOWER (Seal)

THEODORE GILL (Seal)

WILLIAM E. MEEHAN (Seal)

THEODORE S. PALMER (Seal)

BERTRAND H. ROBERTS (Seal)

HUGH M. SMITH (Seal)

RICHARD SYLVESTER (Seal)

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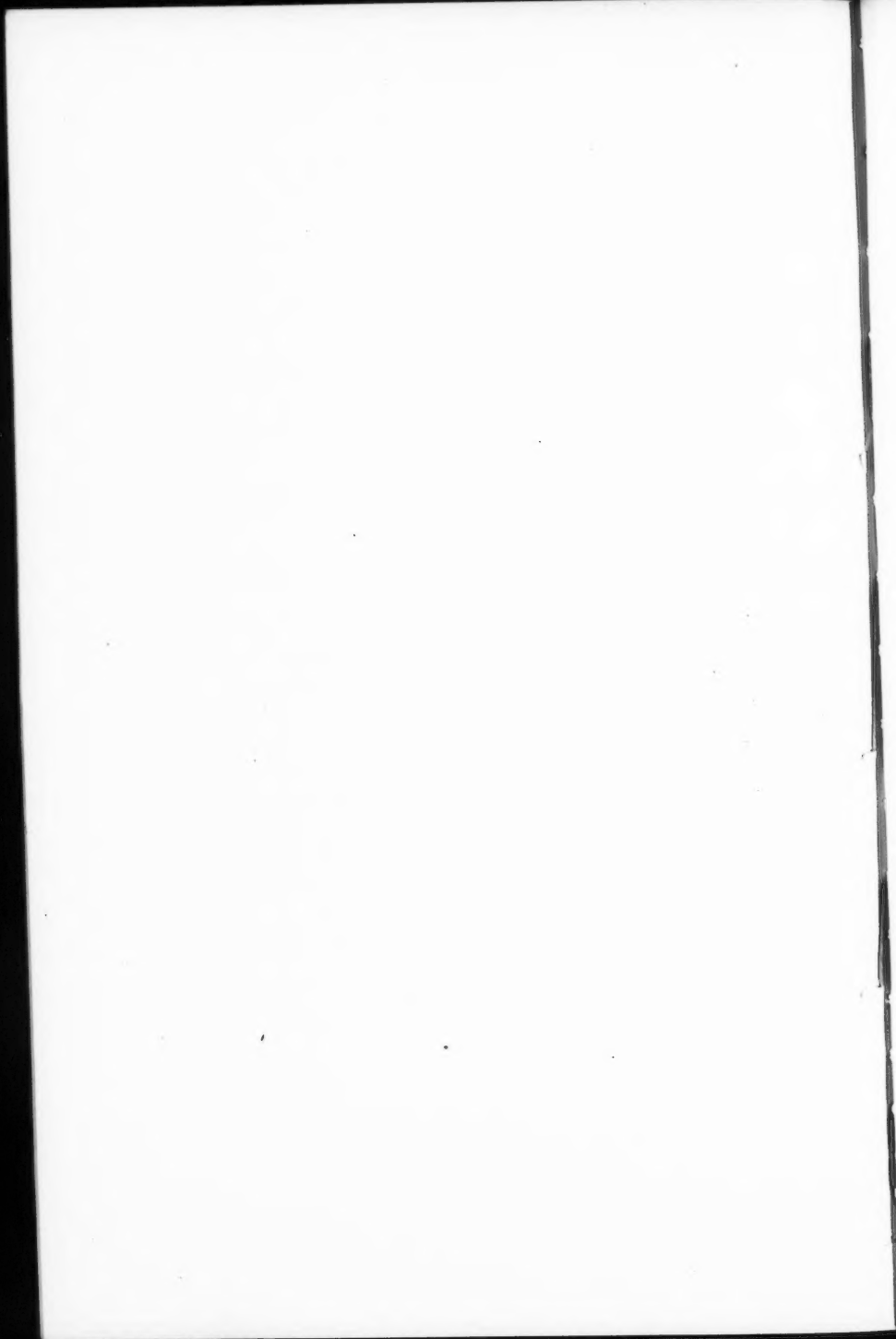
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PART I

BUSINESS SESSIONS



Transactions of the American Fisheries Society

Forty-first Annual Meeting, held at the Planters' Hotel,
St. Louis, Mo., Tuesday, Wednesday, and Thursday, Octo-
ber 3, 4, and 5, 1911.

Tuesday, October 3, 1911

Meeting called to order by the President, Mr. W. E. Meehan, at 10.00 a.m.

MR. L. A. GESERICH: Mr. President and Gentlemen of the American Fisheries Society, the state of Missouri and the Fish Commission appreciate the fact that you hold your 1912 meeting in St. Louis. I am sure you will have a most enjoyable and instructive meeting.

It is now my pleasure and privilege to present to you the Hon. Frederick H. Kreismann, Mayor of St. Louis, who will welcome you. (Applause.)

HON. FREDERICK H. KREISMANN, Mayor of St. Louis: Gentlemen of the American Fisheries Society, our worthy Fish Commissioner, Mr. Geserich, fully expresses my sentiments, and I know that the citizens of St. Louis are much gratified at your coming to our city to hold your annual meeting.

The work in which you are engaged is one that is not only of great practical benefit to this country, but it provides a permanent opportunity for the men of the nation to enjoy themselves with nature. The propagation and protection of the fish life of this country is work of most strik-

ing importance, and one which the governments, both federal and state, have dealt with most liberally. You represent that industry in its most scientific and highly progressive side; we laymen enjoy the benefit of your work.

St. Louis has a great many enthusiastic fishermen, and I know that they are all glad to receive you and to bid you a hearty welcome, and hope that your proceedings will result in much satisfaction and benefit to yourselves. I thank you for your attention. (Applause.)

PRESIDENT: Mr. Mayor and Gentlemen, I wish to thank you in behalf of the members of the American Fisheries Society for the welcome with which you have greeted us, and to assure you that we are glad to meet in this historic city and to carry out our proceedings here. We are interested in the work of fish culture and we are practical fish culturists. We are interested, therefore, in the work which you are doing in Missouri and the advance which you are making here in fish-cultural work. I believe if you continue to progress as you have done you will, in time, place this state among the leading commonwealths of the United States in fish-cultural work.

We hear, Mr. Mayor, a great deal nowadays of the word "conservation." It is in the mouth of everyone. But when the word "conservation" was mouldering in the dictionary for lack of use, the American Fisheries Society was an active conservationist. We claim to be the original conservationists. Before anyone thought of taking a hand in the preservation of the forests, the purification of the streams or the preservation and increase of natural resources generally, there was a band of men connected with this Society who gathered together to advocate the propagation and protection of fish and the conservation of our fish-food supply. It was like many other things, a big project looked upon with ridicule by some and by others as merely a little trick and not at all practical; but today it is recognized as one of the most important conservation activities of the country.

Let me say to the Society in my own behalf, I welcome you here and hope that our proceedings will be productive of as much good in the future as they have been in the past.

There are a few things of importance which I would like to suggest that we attend to during the convention.

There is great need for a change in the phrasing of Article V, of the Constitution, with respect to the publications and the program. There should be, I think, a slight change in the phraseology of Article II, so as to make a little clearer the eligibility of associations in this organization. At the present time it is very much of a stretch of the phrasing to receive into membership a society as a society. I think it should be considered, and if thought desirable, an amendment should be prepared covering the matter.

It is requested that all in attendance upon the meeting register with the Secretary.

REGISTERED ATTENDANCE

The registered attendance was 35, as follows:

S. P. BARTLETT, Quincy, Ill.
TARLETON H. BEAN, Albany, N. Y.
W. H. BOARDMAN, Central Falls, R. I.
WARD T. BOWER, Washington, D. C.
GEORGE T. BRADLEY, Norwood, Minn.
G. W. N. BROWN, Homer, Minn.
W. O. BUCK, Neosho, Mo.
E. E. CALDWELL, Havana, Ill.
EBEN W. COBB, St. Paul, Minn.
S. W. DOWNING, Put-in Bay, Ohio.
L. L. DYCHE, Pratt, Kan.
DANIEL B. FEARING, Newport, R. I.
G. W. FIELD, Boston, Mass.
S. A. FORBES, Urbana, Ill.
G. H. GARFIELD, Brockton, Mass.
L. A. GESERICH, St. Louis, Mo.
HENRY D. GOODWIN, Milwaukee, Wis.
GEORGE H. GRAHAM, Springfield, Mass.
C. W. GREENE, Columbia, Mo.
E. T. GREYER, St. Louis, Mo.
R. S. JOHNSON, Washington, D. C.

PHIL. KOPPLIN, St. Louis, Mo.
H. F. MARDORF, St. Louis, Mo.
WILLIAM L. MAY, Denver, Colo.
W. E. MEEHAN, Mt. Airy, Philadelphia, Pa.
H. WHEELER PERCE, Chicago, Ill.
ROBERT K. ROBINSON, White Sulphur Springs, W. Va.
W. T. THOMPSON, Fairport, Iowa.
FRANK A. TUBBS, Neosho, Mo.
HENRY B. WARD, Urbana, Ill.
ANDREW R. WHITAKER, Phoenixville, Pa.
C. W. WILLARD, Westerly, R. I.
J. S. P. H. WILSON, Auburn, Me.
S. P. WIRES, Duluth, Minn.
STEPHEN G. WORTH, Mammoth Spring, Ark.

NEW MEMBERS

PRESIDENT: We will now receive the applications for membership. The Secretary will read the names.

SECRETARY: The following 51 applications for membership have been submitted:

ARTHUR, S. E., 4345 Washington Ave., St. Louis, Mo.
BALDUS, IGNATZ, 901 Daly St., Indianapolis, Ind.
BORCHERDT, RUDOLPH, Department of Game and Fish, Denver, Colo.
CALDWELL, E. E., Chief Warden and Commissioner, Illinois Fish Commission, Havana, Ill.
CLARK, H. WALTON, U. S. Bureau of Fisheries, Fairport, Iowa.
CLARK, IRA B., U. S. Bureau of Fisheries, Homer, Minn.
CLEVELAND, W. B., Burton, Ohio.
CLUB SHAWINIGAN, Club Shawinigan, St. Maurice Co., Quebec, Canada.
CRASSER, HUGO, U. S. Bureau of Fisheries, Homer, Minn.
DAHL, JOHN, Minnesota Game and Fish Commission, Glenwood, Minn.
DAVIS, FRANK O., State Commissioner of Fisheries and Game, Pomfret Center, Conn.
FREDRUM, JOHN W., 1229 California St., Denver, Colo.
FRENCH, S. L., 1308 Ross Ave., Dallas, Texas.
FULLERTON, WILLIAM ROSS, St. Paul, Minn.
GARFIELD, G. H., Massachusetts Commission on Fisheries and Game, Brockton, Mass.
GEHMAN, CHAS. F., East Greenville, Pa.
GESERICH, L. A., Pres. Missouri State Fish Commission, St. Louis, Mo.
GRETHER, E. T., Chief Deputy Commissioner, Missouri State Game and Fish Department, 1318 Pendleton Ave., St. Louis, Mo.
HAVENHILL, A. D., Fox, Ill.
HEUVER, HARRY J., U. S. Bureau of Fisheries, Duluth, Minn.
*HILL, JOHN F., 136 State St., Augusta, Me.

*Died March 16, 1912.

- JOHNSTON, EDWARD C., U. S. Bureau of Fisheries, Washington, D. C.
LAND, S. E., Department of Game and Fish, Denver, Colo.
McDONALD, CARL K., U. S. Bureau of Fisheries, Neosho, Mo.
MARDORF, H. F., 4068 Olive St., St. Louis, Mo.
MARINE, DR. DAVID, Western Reserve University, Cleveland, Ohio.
MEENTS, R. R., President Illinois Fish Commission, Ashkum, Ill.
MERRIHEW, PERCY T., Neosho, Mo.
MEYER, GUSTAV J. T., 124 South Delaware St., Indianapolis, Ind.
MILES, GEO. W., State Commissioner of Fisheries and Game, Indianapolis, Ind.
MINCH, HARRY C., U. S. Bureau of Fisheries, Fairport, Iowa.
OGELVIE, E. L., Secretary Minnesota State Game and Fish Commission, South St. Paul, Minn.
PATRICK, W. E., Superintendent of State Fish Hatcheries, Denver, Colo.
PELL, GEO. W., 520 Sixteenth St., Denver, Colo.
POHOQUALINE FISH ASSOCIATION, Fifteenth and Walnut Sts., Philadelphia, Pa.
ROTE, E. E., U. S. Bureau of Fisheries, Homer, Minn.
RUCKMAN, CHAS. W., U. S. Bureau of Fisheries, Homer, Minn.
SCHMITT, WALDO, U. S. Bureau of Fisheries, Washington, D. C.
SHINN, JAMES A., Department of Game and Fish, Denver, Colo.
SHIRA, AUSTIN F., U. S. Bureau of Fisheries, Homer, Minn.
SMITH, EMMETT VANCE, Chief Deputy, State Game, Fish and Oyster Commission, Box 217 Capitol Sta., Austin, Texas.
SOUTHALL, JOHN B., U. S. Bureau of Fisheries, Fairport, Iowa.
STERETT, W. G., State Game, Fish and Oyster Commission, Port Lavaca, Texas.
SWIFT, H. F., 307 Crocker Building, San Francisco, Cal.
TONGUE, LEONARD M., U. S. Bureau of Fisheries, Washington, D. C.
VALETTE, LUCIANO H., Chief of Section of Fish Culture, 827 Rivadavia, Buenos Aires, Argentina.
VIQUESNEY, J. H., State Game and Fish Warden, Belington, W. Va.
WALKER, DR. H. T., 210 Main St., Denison, Texas.
WIDMYER, EDGAR R., U. S. Bureau of Fisheries, Homer, Minn.
WILSON, J. S. P. H., Chairman Board of Inland Game and Fish Commissioners, Auburn, Me.
WORTH, HENRY B., U. S. Bureau of Fisheries, Washington, D. C.

Motion made, seconded and unanimously carried electing and admitting to membership in the Society all applicants whose names were read by the Secretary.

PRESIDENT: It is desired that the members of this Society visit the hatchery ponds of the state of Missouri in the park today. We can go by trolley, and I would like to know how many who are present are ready to go this afternoon. The plan is to go at the close of the session. (All signified their intention of going.)

MR. GESERICH: What time do we adjourn this afternoon?

PRESIDENT: If the Society agrees, we will adjourn early, about 4 o'clock, and you can let us know after the session what time you wish us to go.

The next order of business is the report of officers; the first being the report of the President. In my preliminary remarks I made a few suggestions I had in the way of a report.

There are one or two committees that I will announce at the present time. The others will be announced later.

The Program Committee will be: Prof. L. L. Dyche, of Kansas, Chairman; Dr. S. A. Forbes, of Illinois, and Mr. W. O. Buck, of Missouri.

I have here the list of papers as far as they have been presented, and I suggest that the committee group them, and report immediately after luncheon the titles of papers which are to be read today. I would ask that a report be made at the close or beginning of each session.

Committee on Resolutions: Dr. George W. Field, of Massachusetts, Chairman; Mr. S. G. Worth, of Arkansas, Mr. Daniel B. Fearing, of Rhode Island.

This committee will understand, I suppose, that its duties are not only to receive and pass upon all resolutions that may be presented, but also it has the right to originate resolutions.

The Auditing Committee will be: Dr. S. P. Bartlett, of Illinois, Chairman; Mr. W. T. Thompson, Iowa, and Mr. H. Wheeler Perce, of Chicago.

The report of the Secretary, Mr. Ward T. Bower, was then presented.

REPORT OF THE SECRETARY

Mr. President and Members of the American Fisheries Society:

I have prepared no written report, but I will endeavor to tell you briefly of some of the more important occurrences during the past year which, in my judgment, may be termed to be one of the most important years in the Society's history.

First, mention should be made of the incorporation of the Society under the laws of the District of Columbia. Some will recall that this matter of incorporation has been coming up for quite a number of years, including the meeting at New York last year. As a result, we looked into the laws of a number of the states and finally, upon an examination of the code of the District of Columbia, found that the laws there were well suited to our purposes. It is provided by the code of the District that any five persons, a majority of whom shall be legal residents, may have the privilege of incorporating for the conduct of business pertinent to a learned society.

Largely through the efforts of Dr. H. M. Smith, articles of incorporation were drawn under date of December 16, 1910, setting forth the name, objects and purposes of the Society. They were recorded April 15, 1911. As the report of the last meeting did not appear until after the articles of incorporation were complete, it was possible to print the copy in the proceedings, and this was done, the idea being to continue it each year.

It will be noted that there were seven signers of the articles, five of whom are legal residents of the District of Columbia. It was thought proper to add the name of Mr. Seymour Bower, who presided at the meeting in New York when the matter came up, and also the name of Mr. W. E. Meehan, who held the office of President during the current year, thus making seven in all.

Another matter, decidedly in the nature of an innovation, has been the adoption of a membership certificate. This has been possible through the generosity of one of our members, the Hon. Daniel B. Fearing, of Newport, R. I., who stood the entire expense. The work was done by Tiffany & Company, of New York. One of these handsome certificates was mailed to each new member elected at the last meeting. They were lettered by a draftsman at a cost of about 30 cents each.

As an appropriate addition to the certificate of membership the old seal of the Society has been revived. It was originally a conventional design of three crossed fishes which did not represent any particular species. They looked more like mackerel than anything else; but inasmuch as when the Society was founded its members were interested primarily in brook trout, we thought it advisable to have a likeness of the *fontinalis* appear on the new seal. The date of organization, 1870, appears, likewise the date of incorporation, 1910.

Never before has the Society attempted the publication of so elaborate a report as the one appearing since the last meeting, it being a book of nearly 500 pages, and containing 13 cuts and 43 papers, together with the usual discussions of papers and records of the business sessions. A total of 800 copies were printed by the W. F. Roberts Company, of Washington, D. C., the cost being about \$1,200, or nearly \$1.50 a volume. To this must be added the 20 cents for postage or express on each copy sent out. We have been selling a number of copies at \$1 each, although possibly we have not the authority of the Society to do so. A new price ought to be fixed this session. I think the last ruling in the matter permitted the sale at the rate of 50 cents; however, we thought we were justified, in view of the outlay for the volume, in asking a dollar for any of the copies sold. The matter of publishing this report was entirely under the direction of Dr. Smith. The Recording Secretary assisted, as did also the Assistant Secretary.

It will be noted in the published list of members that efforts have been made to state the date of each member's election to the Society. The list has been revised and corrected as far as possible, and members are asked to aid with any further corrections that may be needed. There are very often changes of address of which the Secretary is not aware.

An inventory of the reports on hand is as follows:

1876.....	1	1902.....	8
1888.....	1	1903.....	2
1894.....	1	1904.....	70
1895.....	3	1905.....	3
1896.....	2	1906.....	106
1897.....	2	1907.....	100
1898.....	3	1908.....	125
1899.....	5	1909.....	104
1900.....	6	1910.....	125
1901.....	6		

We have been fortunate in receiving donations of some of the rarer volumes. Mr. Fearing and Mr. Jennings have helped us out in this way. We would like to have further donations, that the bound series of reports, authorized at the New York meeting to be prepared and in the hands of the Secretary, may be as complete as possible.

Compared with last year the applications for membership have been few, though about 50 have been received. If the members would work a little more earnestly in this cause, it perhaps might be possible to extend our membership circle considerably. The accession of only 40 or 50 members does not mean any growth in the Society, because there is bound to be depletion in the ranks through death, resignation, and necessary separation for delinquency in payment of dues.

Since the last meeting the death of 10 members has been reported. Following are the names and dates, together with date of election to membership in the Society:

- MOSES H. CONE, Greensboro, N. C. Died December 8, 1908. Death reported only last year. Elected to membership in 1903.
- FRANK N. CLARK, Northville, Mich. Died December 19, 1910. Elected to membership in 1884.
- WILLIAM CUTLER, Comstock Park, Mich. Died December 26, 1909. Elected to membership in 1906.
- HOWARD M. BULLER, Bellefonte, Pa. Died December 22, 1910. Elected to membership in 1904.
- F. C. ZACHARIE, New Orleans, La. Died January 6, 1910. Elected to membership in 1904.
- J. W. BRACKETT, Augusta, Me. Died June 24, 1911. Elected to membership in 1910.
- E. A. JAGGARD, St. Paul, Minn. Died January, 1911. Elected to membership in 1908.
- ARTHUR SYKES, Madison, Wis. Died March 18, 1911. Elected to membership in 1900.
- H. D. CHICHESTER, Washington, D. C. Died May 31, 1911. Elected to membership in 1910.
- EDWARD BIRBECK, London, England. Died 1908. Elected to membership in 1884.

Four resignations have been received, as follows:

- ALBERT L. BARROWS, formerly of Cavite, P. I., now of Nordhoff, Cal. Resigned January 13, 1911. Elected a member in 1908.
- OLIVER ADAMS, Toronto, Canada. Resigned July 24, 1911. Elected a member in 1908.
- GEORGE H. SHERWOOD, New York City. Resigned July 26, 1911. Elected a member in 1903.
- W. A. LEISENRING, Mauch Chunk, Pa. Resigned September 26, 1911. Elected a member in 1906.

I might mention in passing that it was necessary for me to be out of the country some four months this summer, and during my absence all the Secretary's matters were carefully looked after by the Assistant Secretary, Miss Ethel M. Smith.

WARD T. BOWER,
Secretary.

The Secretary's report was then, by unanimous consent, approved and placed on file.

STYLE OF PUBLICATION OF TRANSACTIONS

MR. FEARING: May I ask a question in regard to these Transactions, simply as a matter of interest in making the index. I wanted to ask if that last volume of Transactions was intentionally printed with each article ending on one page, and then the following article skipping a whole page,

with the idea of members being able to take out an article without taking any print on the other side; because if that book had been printed in the ordinary method its paging would have been reduced considerably, and would not have cost as much.

SECRETARY: It might have been reduced 30 pages or so.

MR. FEARING: I counted them. It would have reduced it considerably more than 30 pages.

SECRETARY: The preparation of this report, I think, represents the very latest idea in artistic book making.

MR. FEARING: I simply asked, because a great many of the foreign societies publish their transactions in that manner. The idea seems a very good one, for you can take out the article as a separate if so desired.

PRESIDENT: I presume you paid for the blank pages the same as if they were printed.

MR. FEARING: I think there are over 40 such pages.

SECRETARY: Yes, something like 40. A reduced rate was made by the printer for the blank pages which appear in the report. The work was under the direction of the chairman of the Publication Committee, Dr. H. M. Smith, who has charge of the preparation of the federal publications on similar matters. I believe the expense was fully justified, and that anyone who examines the book critically will be of the same opinion.

Referring to Mr. Fearing's remarks, we could have at the immediate conclusion of a paper started in with another title, but that would not have been a fair sample of the up-to-date book-maker's art.

MR. FEARING: I thought the idea was to take separate articles out, and if so I think it is a very advisable method to pursue.

SECRETARY: That was the principal idea in view.

TREASURER: Our Secretary states that the expense of getting out this report was about \$1,200. I think that the cost of stenographic work at the meetings should be included as part of the expense of getting out the reports. It is quite

necessary that the meetings be reported by a stenographer in order that the discussions may be made a part of the printed Transactions. It is logical that this item should go in as part of the expense. Therefore this year the report actually cost us nearly \$1,500 instead of \$1,280.

SECRETARY: That charge may be very properly included as part of the expense of getting out the Transactions.

TREASURER: My reason for making these remarks is that the members who do not pay their dues promptly may understand the heavy annual expense of getting out this report; and when the Society is obliged to pay \$1,500 for 800 reports, it will be seen that the cost is nearly \$2 a volume. Every member ought to realize this, and should be more than willing to pay his dues. He certainly gets in the document value received for his dues.

SECRETARY: You want to remind members to pay up their dues?

TREASURER: Yes.

PRESIDENT: We will now have the report of the Treasurer.

At the request of Mr. Willard the report was then read by the Secretary.

REPORT OF THE TREASURER

To the American Fisheries Society:

I herewith present my annual report as Treasurer from September 27, 1910, to October 3, 1911.

RECEIPTS

1910		
Sept. 27.	Balance cash on hand.....	\$222.79
	Reports sold	17.00
	Dues and admission fees	862.00
		<hr/> \$1,101.79

EXPENDITURES

1910		
Sept. 27.	Sundry expenses New York meeting.....	\$ 3.90
" 28.	B. W. Evermann	1.25
" 28.	Ward T. Bower, Sec., postage, etc.....	19.80
Oct. 8.	Seymour Bower, postage, etc.....	28.44
" 8.	Irving Press, programs, etc.....	49.40
" 15.	Stamped envelopes	10.72
" 31.	W. F. Roberts Co., printing.....	15.25

Nov. 12.	C. J. Butler, envelopes.....	\$10.72
" 15.	Goodwin & McDermott, stenographers.....	196.40
Dec. 2.	W. F. Roberts Co., printing.....	7.25
1911		
Jan. 1.	Postage stamps	1.00
May 16.	Ward T. Bower, Sec., postage, etc.....	18.45
June 7.	W. F. Roberts Co., annual reports.....	1,280.64
" 28.	500 stamped envelopes.....	10.72
" 28.	Dr. H. M. Smith, postage.....	5.00
July 17.	500 circular letters, by Treas.....	1.50
Sept. 8.	Dr. H. M. Smith, postage.....	5.00
		<hr/> \$1,665.44
1911		
Oct. 3.	Balance due Treasurer.....	\$563.65
		<hr/> \$1,665.44

Respectfully submitted,

C. W. WILLARD, *Treasurer.*

WESTERLY, R. I., October 3, 1911.

The report was duly received and referred to the Auditing Committee.

PRESIDENT: The next subject will be reports of Vice-Presidents of divisions.

SECRETARY: Dr. Evermann states that he will have no report available this year concerning the division of aquatic biology and physics. Mr. Gunckel advises that he will be here before the close of the meeting and will present a report on angling. I talked with Dr. Palmer two or three days ago, and he said that he had some items which he wanted to present to the Society on the subject of protection and legislation. The material will be submitted as a paper for publication in the next report, provided such action is agreeable to the Society. The topic proposed by Dr. Palmer is of timely interest, referring as it does to the action of various states in the licensing of hook and line fishing.

PRESIDENT: We will take up the reports later on if any are ready for presentation.

The Executive Committee, of which Dr. Charles H. Townsend is chairman, is next called upon for a report. Is there any other member that can make a report for the committee, in the absence of Dr. Townsend? Dr. Ward, have

you anything to say about the Executive Committee's work during the year?

DR. HENRY B. WARD, Urbana, Ill.: I am not aware of any business to report, Mr. President.

PRESIDENT: Mr. Fearing, have you anything to say in reference to the work of the Executive Committee during the year?

MR. FEARING: I saw Dr. Townsend and he said there was nothing. He will not be here.

PRESIDENT: Will the chairman of the Program Committee report the titles of any papers that may be read before noon?

PROF. L. L. DYCHE, Pratt, Kan.: We have not had opportunity for a conference, but I see no reason why if we have time we should not begin the reading of papers.

PRESIDENT: Will the committee get together and recommend some papers to be read before the close of the morning session? I would suggest that while we think about it, some one make a motion as to the time we shall convene after luncheon.

SECRETARY: Would not 2 o'clock be a suitable time? Judging by the experience of previous meetings this seems to be the usually accepted hour.

PRESIDENT: I might say that, as in the past, it will be considered in order at any time when actual business is not in progress for the Committee on Resolutions to present a report. Between the reading of papers or at any other time during the sessions, that committee has priority over other matters.

The Program Committee has made a preliminary report and I have been called upon to open the skirmish. (At the President's request Mr. Boardman took the chair.)

The President then read a paper on the subject of "Goitre Among Trout, and Efforts to Eradicate It," which paper was discussed.

A recess was taken until 2.00 p.m., same day and place.

At 2.00 p.m. meeting called to order by the President.

DR. S. P. BARTLETT, Quincy, Ill.: My object in asking your attention for a moment is to announce that my colleague, Mr. E. E. Caldwell, of the Illinois Fish Commission, is here and tells me that the steamer *Illinois* is now at the wharf, and that if desired there will be plenty of time to hold a meeting on the boat while running to Alton and back. On behalf of the Illinois Fish Commission Mr. Caldwell tenders the use of the steamer for that purpose.

PRESIDENT: A meeting on the boat will be very pleasant, and in the absence of any objection we accept with thanks Mr. Caldwell's very kind offer. Two o'clock will be a suitable time for starting.

MR. E. E. CALDWELL, Havana, Ill.: Any time that meets with your convenience will suit us. Please come to the foot of Franklin Avenue, just above Eades Bridge.

PRESIDENT: The meeting tomorrow afternoon will be held on board the steamer *Illinois*. We will meet there at 2 o'clock.

DR. TARLETON H. BEAN, New York: I move that the thanks of the Society be extended to the Commissioner of Illinois for his courteous invitation.

Motion seconded and unanimously carried by rising vote amidst applause.

The Secretary then read an invitation for the Society to visit the Merchants' Exchange of St. Louis.

PRESIDENT: I will announce my committees.

Nomination Committee: Dr. Tarleton H. Bean, New York, Chairman; A. R. Whitaker, Pennsylvania; W. H. Boardman, Rhode Island; R. K. Robinson, West Virginia; S. P. Wires, Minnesota.

Committee on Time and Place of Meeting: S. W. Downing, Ohio; W. L. May, Colorado; Dr. Henry B. Ward, Illinois.

Publication Committee: Dr. H. M. Smith, Washington, D. C.; Ward T. Bower, Washington, D. C.; Miss Ethel M. Smith, Washington, D. C.

The Secretary then read several communications extending formal invitation to hold the next annual meeting at Boston, New York, Portland, Oregon, and San Francisco. These communications were referred to the Committee on Time and Place of Meeting.

PRESIDENT: We will proceed with the reading of papers, first hearing from the Program Committee, of which Professor Dyche is chairman.

PROFESSOR DYCHE: The Program Committee has selected three numbers for this afternoon; first we will hear Mr. D. B. Fearing's remarks on a proposed index to the Society's Transactions. We will then have the paper entitled: "Is Irrigation Detrimental to Fish Culture," by Mr. W. T. Thompson, U. S. Bureau of Fisheries, Fairport, Iowa. This will be followed by a paper on the subject: "Utilization of the Dogfish," by Dr. George W. Field, Boston, Mass. These three offerings are selected for the meeting this afternoon.

PRESIDENT: We will hear from Mr. Fearing first.

INDEX OF THE TRANSACTIONS

MR. FEARING: In the Assistant Secretary's report at the last meeting of this Society he suggested that "in view of the scarcity of the early reports, a card index embracing the history of the connection with the Society of both past and present members would be a most valuable adjunct to the records. The careful compilation of such an index, covering the entire period of the Society's existence, would probably cost from \$25.00 to \$50.00." This matter of an index was later discussed, bringing out the fact that an *author's* index had been worked up by Mr. Bower, and this was later published in connection with his article on the History of the Society, which appears in the volume of the Transactions of the fortieth meeting in 1910.

Mr. Titcomb, Mr. Meehan and others were ready to give their share toward the publication of a proper index of *subjects* as well as of authors, and it was decided that it should be made on cards, and later published so that members might have copies. Mr. Clark moved that a committee be appointed to report at the next meeting in regard to the probable cost of compiling such an index as was proposed. At this point, knowing something of the need and uses of indexes of reference, and having an almost complete set of the Society's Transactions, I innocently offered to have the index made and have enough copies printed to send one to each member of the Society. Upon a motion previously before the Society, it was voted that Dr. Smith be made chairman of a committee, the Secretary, Mr. Titcomb and myself to make up the members, and my offer was accepted with thanks.

On going over my set of the Transactions I discovered that I lacked Volume VIII as well as the first five volumes, but these were kindly loaned to me by the Bureau of Fisheries. Since then I have obtained all except the first and eighth, and once more I will say that I shall be very glad to pay any price within reason for these two.

The work of making an index of the Transactions of this Society as full and as detailed as seems desirable has proved to be a "big job," as Mr. Titcomb prophesied—and I can, after the lapse of a year, only report progress, and not produce the finished product as I had hoped to be able to do.

The Transactions, including those of the last meeting, have been indexed fully by author, subject, and title, and between 800 and 1,000 entries made. Before compiling this index, however, preparatory to its publication, a great many questions and problems have arisen that it would seem well to have the members themselves discuss and offer their own answers and solutions for.

My librarian, who has done the indexing, has made out a list of questions which I will ask you to discuss as fully

as time will permit. I shall be very glad to consider any suggestions of changes or improvements offered by members who have used, or tried to use, the Society's publications for reference purposes.

The first question is: Shall the titles of the papers presented at the different meetings be indexed under the first word not an article? For example, the paper, "Some of the Difficulties Encountered in Collecting Pike Perch Eggs" would ordinarily be put under the head of Pike Perch.

PROFESSOR DYCHE: It seems to me that the rules that are followed in ordinary library indexing might very well be followed in indexing these reports.

SECRETARY: In my opinion the ordinary principles of indexing should be applied. Poole's Index or any standard index would be a good pattern. Take, for instance, the paper referred to on "Some of the Difficulties Encountered in the Collection of Pike Perch Eggs," it would be rather unusual to index it under the letter "S" simply because it is the first letter of the title. The subject matter should be the guiding factor, and thus in the present case "Pike perch" would be the natural heading. There should, of course, be appropriate cross references.

I think that the general principles of indexing with cross-references should apply in Mr. Fearing's index. Care should be taken not to make the affair too cumbersome.

MR. FEARING: With the permission of the Society I will go ahead and do the indexing the way I have started it.

DR. BEAN: I would like to say that if Mr. Fearing should index the paper mentioned under "Pike perch," and then have a subhead "Difficulties of taking eggs," he would cover the ground very satisfactorily.

SECRETARY: It would hardly be necessary to make a reference under so general a heading as "Fish culture," for this would merely make the index cumbersome rather than suggestive. It is about the last place one would look in such an index for information on pike perch eggs.

MR. FEARING: That covers that point. Another thing of importance is in regard to reports of the Treasurer and various committees. There are 41 different Treasurer's reports, thus necessitating 41 references.

SECRETARY: Could not one general reference be made to suffice?

MR. FEARING: We cannot have one reference. There is a Treasurer's report for each year of the Society's existence.

SECRETARY: But they would appear only in one place in the index. There would be no cross references.

MR. FEARING: That is so. It could be simplified in that way. That was our idea if it met with the Society's approval, because otherwise it would require a great deal of space.

The next question is: Under broad subjects like "Apparatus," would you care to have the references in the order of the years in which they come, or alphabetically? That is to say, for instance, under the head "Apparatus," would the order be "Brackett's trays" and then "Ainsworth's screens"? Brackett's trays came out first and Ainsworth's screens afterward. Logically the reference to Ainsworth's screens should be first in the index.

SECRETARY: I think an alphabetical arrangement is by all odds the best.

DR. H. B. WARD: It seems to me that we passed one little item without note, that in some cases may have considerable importance: I refer to the reports of committees. Reports of Nominating and Auditing Committees, etc., would be of little value if indicated under forty different headings. On the other hand, if there is a committee on international relations or a committee on best methods of handling certain matters, it might be important to get at the report of the committee. The report of the committee in such case would seem to me to have a permanent value, whereas the report of an auditing or nominating committee has very little permanent value.

MR. FEARING: I think, perhaps, if it is satisfactory. I might pick out the important committees.

DR. WARD: Personally I do not think any better plan could be found.

MR. FEARING: Another question is: Shall the subject entries be followed by the name of the author? As for example, "Fish Culture—A Practical Art; by J. H. Bissell."

DR. WARD: There is only this to say, speaking personally again, I have recalled that in a certain year Mr. Dwight Lydell said something in a paper on the bass that bore on another point, and if one had to hunt through every paper on the bass to find which one Mr. Lydell wrote, it would be hard to get at that specific information.

MR. FEARING: You will find it under the heading "Lydell, remarks on black bass." There is really a double entry of the author's name, for it would appear both under the headings "Lydell" and "Black bass."

The next question is: Shall authors' names be entered in full, or as given in the list of members, or with initials of first names only?

There are many men who, perhaps, for the purposes of this Society use a middle name, as A. John Brown, instead of A. J. Brown. It is as simple one way as the other, to put them in as they are given in the list of members, or otherwise. In many cases it is almost impossible to give the full name correctly.

SECRETARY: Perhaps it would be best to have no hard and fast rule. Simply make the entry according to the author's signature.

MR. FEARING: The simplest way would be to give the name as it appears in the list of members.

Another question is: Shall the reference be given to the year of meeting or number of meeting?

DR. WARD: There is one point here, that we all should bear in mind, and that is that all librarians who bind these proceedings will put on the back the number of the volume and not the year, or if they put on the year they may put on the year of publication, which is the date recognized, and not the year in which the paper was read. Now that will render

it difficult to refer from this index to a set of the Transactions on the shelf of any public or scientific library. If I am not mistaken, in the library indexes, like Poole's Index, reference to such societies take the volume number as contained on the title page, and not the year. Consequently our references would not agree with the standard library index references.

SECRETARY: Do they not contain both the volume number and the year?

DR. WARD: The year of publication and not the year of meeting. In the printing of scientific bibliographies I think that custom is absolute. The year of publication is the only date recognized, and not the year in which the meeting happened to be held.

MR. FEARING: You need not worry about anybody going to look up the records of this Society in any public library, for the only complete set is in the library of the Bureau of Fisheries at Washington.

DR. WARD: As a teacher I feel this side of it. Personally I shall refer to the publications of this Society, not to all of them, because we have not access to all of them.

There are certain things that are very important, and those things ought to be used more and more in our institutions where teaching along biological lines is carried on, lines that involve the work that the Society is doing. I believe the Society can gain wider influence and can exert greater power in the development of this subject if we can only get the periodicals where they can be referred to. I have cited people to publications of this Society and they have replied to me that unfortunately they cannot be found in the library. So there is a real difficulty. Nevertheless, in some libraries in the larger cities, it is possible to get a considerable number of the publications of this Society, and it ought to be possible in future to get all of them.

I think that the great libraries in our cities should have as nearly a complete series as possible. I know of two cities that have recently searched out as nearly a complete series

as possible. Now, that is of importance here, because if we are to make this index useful to the public seeking information on fish matters, and to the patrons of libraries, the index must be put in the form in which an index is usually found. So I think the proposals here to follow what is the customary method of indexing are really very important for the welfare and interest of the Society.

SECRETARY: May I ask if there is to be an index of the material embraced in the discussions?

MR. FEARING: That will come in under the discussion of each paper.

PRESIDENT: Without cross references?

MR. FEARING: With cross references—for instance, if Mr. Clark and Mr. Meehan had one of their discussions on fry and fingerlings, it would be indexed "Meehan, remarks on fry," and "Clark, remarks on fingerlings." The heading, "Fry and fingerlings," would also give the references.

SECRETARY: Discussions sometimes wander over a wide variety of subjects, and it is hard to get at the meat of them.

MR. FEARING: It makes indexing very difficult. I remember in one instance where the discussion started on the pollution of water and ended up on fry and fingerlings, and it went the whole gamut between, on almost every known subject. (Laughter.)

DR. WARD: There is one other point concerning which I should like to inquire. I am not perfectly clear from what I have heard whether this index is to be printed as a separate pamphlet or in connection with the volume of Transactions.

MR. FEARING: I was going to ask about that. It seems to me if it will be of any use to the Society it would be better to have it printed as an addition to the Transactions, where it can always be found.

SECRETARY: As a part of the Transactions?

MR. FEARING: Yes, but I am open to suggestions. An index bound as a separate volume is very apt to be mislaid.

DR. WARD: And not only that but the index if printed as a separate pamphlet may not get into the hands of the libraries that get the volumes. Then the library, which certainly needs the index as much as any individual could, would be without that essential part.

SECRETARY: It would make a rather voluminous affair. You will note that the little author's index which I worked up last year, where only one reference is made to each of the 433 papers published, occupied 15 pages in the report. The complete index Mr. Fearing is preparing will make quite a volume.

MR. FEARING: But the index ought to be in the hands of every owner of the volume, and as Dr. Ward says, if published separately it is very apt to be missing.

SECRETARY: Undoubtedly the most desirable place for it is in the regular volume of the Transactions. By using small type and arranging the material perhaps in double columns on a page, the whole thing can be put in more compact form than I at first thought.

MR. FEARING: I would be glad to pay a certain proportion toward doing it.

PROFESSOR DYCHE: Would it not be wise to have it printed both ways, to have a certain number of Transactions and a certain number of separate copies also? It is often done. I never heard of their being lost. It is very unhandy to pull down a large volume just to get at an index.

SECRETARY: Reprints could be made.

MR. FEARING: There could be a certain number of reprints that the Society could sell.

PROFESSOR DYCHE: I would rather have it separate and not connected with the volume. I do not care about pulling down the largest volume in the series to get at the index. I would rather have the index by itself every time.

DR. WARD: Have you calculated the size of the index when printed?

MR. FEARING: It is a hard thing to estimate, as it all depends on the size of the type used. But it will probably be 115 or 120 pages or more.

DR. WARD: In view of the very liberal offer of Mr. Fearing to assist in this matter, I should like to move that the Society undertake to carry out the printing of the index, and that the question of securing reprints of this part be left to Mr. Fearing and the Secretary, their opinion to be based on what seems to be the demand for a separate publication of that portion.

Seconded by Dr. Bean, unanimously carried and so ordered.

A paper by Mr. Thompson was then read and discussed.

Dr. Field then presented his paper.

PRESIDENT: I would suggest that the discussion of Dr. Field's interesting paper be deferred until tomorrow morning as the time has arrived when we agreed to visit the hatchery ponds at the park. If there are no objections we will leave the discussion until tomorrow. Before we go I would ask that you set a time for the meeting tomorrow.

SECRETARY: I move that we convene at 9 o'clock tomorrow morning.

Seconded by Professor Dyche, and unanimously carried. Adjournment then taken.

Wednesday, October 4, 1911, 9.30 a.m.

Meeting called to order at the same place by the President.

The visit of the members of the Society to the Forest Park fish-cultural station was discussed.

PRESIDENT: We will listen to the report of the Committee on Time and Place of Meeting.

TIME AND PLACE OF NEXT MEETING

MR. S. W. DOWNING, Put-in Bay, Ohio: A majority of the committee has decided on Denver as the place for the

next meeting, but the time has not been fully decided on, although it will be early in September—we could not get the date.

PRESIDENT: Will you make a further report?

MR. DOWNING: Yes, we will report the date this afternoon.

PRESIDENT: You say that is a full report of the committee or just a majority report?

MR. DOWNING: It was made unanimous.

PRESIDENT: You hear the report of the Committee on Time and Place of Meeting. What action will you take?

PROFESSOR DYCHE: I move the report of the committee be accepted.

Seconded.

DR. FIELD: I have a cordial invitation for the Society to hold its meeting in Boston, with meetings also in Providence and Gloucester; but we do not want to press the matter this year. We believe there are many reasons why we should go to Denver next year but we do want to put ourselves in line for consideration the following year. We have not met in New England for a great many years, and we believe that Massachusetts, Rhode Island and Connecticut should have some consideration in this matter. We can assure you that you will receive a most cordial reception.

Now another question arises: I chance to be Secretary of the Association of Game Commissioners, and I think without doubt we can arrange to have the meeting in Denver either just before or just after the meeting of this Society, which seems desirable.

DR. WARD: There has been some doubt expressed by various people, possibly because they did not understand the situation, as to the advisability of holding the convention in Denver. I believe it would be wise to have Mr. May tell the Society what he has in the way of information regarding the Denver situation.

MR. W. L. MAY, Denver, Colo.: I did not get a chance to lay before the committee what we had in the way of in-

vitations. It has been the custom heretofore to present these invitations from different bodies, towns and cities directly to the committee, without referring them to the meeting. But if you do not mind I would like to read extracts from invitations we have in favor of Denver.

The Denver Convention League writes:

The Denver Convention League, on behalf of the business interests of this city, extends to your organization a most cordial invitation to hold its 1912 session in Denver.

We have in this city and state many enthusiastic sportsmen and we believe that if a session of your organization were held in Denver that a considerable accession of members could be obtained. Apart from the interesting sessions of your Association your members would be delightfully entertained at the nearby fishing places which abound in this locality.

Many of your members have doubtlessly visited this state and know of its many advantages both as to climate and scenery, and it is therefore not necessary to enlarge on these points.

We will act in perfect harmony with the members of your organization located in this state in the endeavor to make your session here the most successful one ever held in your history.

A communication from the Denver Chamber of Commerce includes the following:

The Denver Chamber of Commerce desires to join with the Denver Convention League and other commercial bodies in extending to your Society a hearty and cordial invitation to come to Denver in 1912.

We believe that the entertainment Colorado can offer you is unexcelled by any other commonwealth in the Union, and nothing would give us more pleasure than to be the hosts of the members of your Society and show them the "Sportsman's True Paradise"—Colorado.

Another invitation is from the Colorado Sportsmen's Association, as follows:

At a meeting of the Colorado Sportsmen's Association held September 9, it was unanimously resolved to invite your Society to hold its next annual (1912) meeting in our city.

Colorado has well been denominated the nation's playground. It can also, with good and sufficient reason, be called the trout fisherman's paradise.

The majority of us imagine we are well equipped mentally and otherwise, to kill fish, but very few are versed in even the rudiments of fish propagation, and the addresses of your members would be of great educational value.

We will be more than pleased to extend every courtesy within our power, and trust that it may be possible to arrange as one of the features of your entertainment a visit to our new club house on the South Platte. We feel confident that the holding of your meeting in our city will not alone add materially to your membership, but greatly to our knowledge of fish culture as well.

The Hon. Robert W. Speer, Mayor of Denver, extends the following invitation:

It gives me pleasure to join in the invitation to your Association to hold your next session in Denver. The city administration will be pleased to co-operate in every manner possible with the local commercial bodies in extending your members a genuine western welcome, and every effort will be put forth to make your visit to our city agreeable and instructive.

From Governor Shafroth we have the following:

In behalf of the people of the State of Colorado I wish to extend to you an invitation to hold your next annual meeting, for 1912, in the city of Denver, in this state.

On account of Colorado being a western state, and its mountains being covered with original forests, and on account of the enforcement of the game laws of this state, we have still left considerable game in our mountains. We have here associations composed of sportsmen, many of whom are residents of the city of Denver. The Game and Fish Department of the state of Colorado has in every way attempted to preserve the game and fish and has stocked the streams with fish and placed in the forests much game.

Denver is an excellent city in which to hold a convention. The climate in summer is ideal. Within two or three hours' run, in the hottest weather, you can reach the region where perpetual snow exists, and in going you pass most superb wonders in scenery.

From Mr. James A. Shinn, State Game and Fish Commissioner, comes the following:

I want to join Governor Shafroth in giving your Society an invitation to hold its 1912 Convention in Denver. If you conclude to do so, I will say, in behalf of the people of the state of Colorado, that we will see that you get your fill of speckled trout from our sparkling streams, as well as bear, deer and grouse. You can visit some of the eight fish hatcheries that are now being operated by the state, from which we will be able to distribute some 29,000,000 of fry by the close of 1912. The Denver fish hatchery is located near the city and can be reached by automobile.

We get two hatches of spawn per year, and take the native and rainbow spawn in the late spring and early summer, while our brook trout begin spawning the first ten days in October.

We consider our game and fish and our wonderful mountain scenery as one of our best assets. Thousands of people from other portions of the Union visit our state for the purpose of hunting and fishing during the heated season at home.

Report unanimously adopted as to the place of meeting.

PRESIDENT: The next place of meeting is, by unanimous vote, the city of Denver.

In accordance with the action of the Program Committee we will take up an address by Dr. S. A. Forbes on "Definite Results of Survey Work on the Illinois River."

The address was delivered and discussed.

PRESIDENT: If there is no further discussion we will proceed with the next paper. I will call on Professor Dyche for his paper.

PROFESSOR DYCHE: This plan for a fish hatchery has some things about it that need to be discussed, though I have no pet theory to exploit. I am going to try to found a fish hatchery suitable for conditions in the state of Kansas, and I desire the members to discuss it. I want to ask questions myself, and hope to be asked questions; because if I am making any mistakes I want to know it right away. The hatchery will be built in a short time, and I want to be as straight as possible before starting in on it. As there will be considerable discussion I think it would be better to take some other paper now.

PRESIDENT: Then we will take the following paper: "The Absorption of Fats by the Alimentary Tract with Special Reference to the Function of the Pyloric Cæca in the King Salmon, *Oncorhynchus tshawytscha*," by Dr. Charles W. Greene, Department of Physiology, University of Missouri, Columbia, Mo.

The paper was then read.

PRESIDENT: We will have to leave the discussion of this interesting paper till the afternoon session. The papers read have provoked so much discussion that we are behind, and a session this evening will be necessary. The meeting will be called this afternoon on the steamer *Illinois*. Be sure to be at the wharf a few minutes before 2 o'clock. Dr. Bartlett

and one or two more will be at the hotel to show the way. We will leave the hotel here at quarter of two.

Recess was taken until 2.00 p.m., to meet on the steamer *Illinois* at that time.

The President called the meeting to order at 3 o'clock p.m., same day, on board the steamer *Illinois*.

SECRETARY: The Anhaeuser-Busch Brewing Company extends a cordial invitation to us to inspect their plant at our convenience, but preferably before 4.00 p.m. It is asked that we inform them of the time selected that they may give the Society hospitable attention.

PROFESSOR DYCHE: I move that this invitation be accepted. Being from Kansas I think it is proper for me to make the motion. (Laughter.)

PRESIDENT: Will the Professor set the time?

TREASURER: I suggest that the time be from 4.00 p.m. to 8.00 a.m. (Laughter.)

The invitation was then unanimously accepted.

DR. BARTLETT: I want to say that the Anhaeuser-Busch brewery is one of the most interesting manufacturing plants in the West, and it covers the largest area of ground. I have no doubt your reception will be all that you can ask for, over and above what you want to drink.

PRESIDENT: Will you state a time so that we may notify the company when we will be there?

SECRETARY: Is it not probable that our business will be finished by 3 o'clock tomorrow afternoon?

PRESIDENT: Yes.

SECRETARY: Then I move that we go out immediately after adjournment tomorrow.

Motion seconded and unanimously carried.

SECRETARY: A communication is at hand from Mr. Charles Flegel, member of the Imperial Fisheries Society, Vienna, Austria, and a corresponding member of the American Fisheries Society. It is in relation to the sponge fishery of the Mediterranean. It is quite a long communica-

tion and possibly it would be well not to read it at the present time. It calls for action I think by the Committee on Foreign Relations or the Committee on Resolutions. With the President's consent it might be referred to the proper committee.

PRESIDENT: I would suggest that a motion be passed to refer to the Committee on Foreign Relations with power to act.

So moved by Dr. Greene.

Motion seconded, unanimously carried, and so ordered.

SECRETARY: Some years ago authority was granted to sell reports of the Society for 50 cents a copy. It occurs to me that it would be well to increase this price, inasmuch as 50 cents does not represent the cost of getting out one of the reports. Even the less pretentious offerings cost more than 50 cents a copy. I think it would be well to increase the price to one dollar a copy. I submit this as a recommendation.

Another question it would be well to consider is the time of the payment of dues by applicants for membership. Heretofore when names have been proposed for membership the money has not accompanied the request. It has not been the practice to ask for payment of dues until after the member has been elected. I think it would be well for the Society to adopt a rule requiring that the fee shall accompany the application for membership.

Another matter of importance is a proposed revision of the Constitution, particularly Article V, relating to the order of business.

PRESIDENT: I think that is in the hands of the Committee on Resolutions now. It has reference to the change in Article V as to the order of business, is not that the case?

DR. FIELD: I did not know that it had been formally referred to us.

SECRETARY: You refer to Article II, do you not?

PRESIDENT: Article II and Article V. There are omissions in Article V that necessitate some changes.

If the Committee on Nominations is ready we will receive the report this afternoon.

DR. FIELD: Has any action been taken in regard to the amount of money due Mr. Willard? He has advanced certain moneys. It is entirely unjust for the Treasurer to have to advance funds in that way.

SECRETARY: Inasmuch as the dues are now collectable for the coming year, possibly much of the deficit will be wiped out within a month at the outside, and if we inaugurate the campaign proposed for the collection of dues from our delinquent members I believe that it can be wiped out entirely.

MR. FEARING: It amounts to nearly \$600.

SECRETARY: The expense for printing the next report will not come up until probably along in January or February, so that everything that is collected for the next few months can be applied on the debt. I believe we have something like \$100 on hand now, that has just come in.

PRESIDENT: Do you think the amount coming in will cover the deficit?

TREASURER: No, I think not. Our Secretary refers to the amount in hand of about a hundred dollars; but there are some debts unpaid that will practically wipe that out.

SECRETARY: That is so.

TREASURER: I do not see that we can do anything more than we have done right along. I have not asked for any action to be taken in this matter. The most I might ask for perhaps would be a vote authorizing the Treasurer from time to time, as he may deem necessary, to hire such money as may be required to carry on the work of the Society. I have not found any fault, and if I am re-elected to office, I will do my best to gather in all the funds possible. I do not think I shall find any fault in the matter. But I do think that perhaps a vote authorizing the Treasurer to hire such sums of money as may be necessary might be in order.

MR. GEORGE H. GRAHAM, Springfield, Mass.: I would like to ask how many members there are in the organization?

SECRETARY: About 625.

MR. GRAHAM: It seems to me that an organization of this kind, doing the work we are doing, ought to have ten times as many members as we have. If people generally knew, if our sportsmen knew, what this Society is doing, I think we could get a thousand members tomorrow, and then we would not have any deficit. Let us increase the membership.

TREASURER: That really is the keynote of the whole situation. We can get along nicely with the present dues if we can only increase the membership to a thousand. We have now about 600 members and it would not be difficult if everyone would put his shoulder to the wheel. There should be no great trouble getting a thousand members in a Society like ours.

SECRETARY: A year ago a campaign was inaugurated to secure new members. At the office of the Bureau in Washington we had access to the names of many fish and game clubs in the country, and we sent out hundreds of circulars. As a result of that campaign something like a hundred new members were secured. It is surprising to know what little attention is paid to anything of the sort. However, I trust that Mr. Graham can suggest some plan of action to increase the membership.

MR. GRAHAM: Sending out letters is all right, but nine out of ten people throw them in the waste basket. The best way to do it is for each member to procure a number of new members. Every man here could, if he tried, secure 10 members before the next meeting. I believe that I can secure 25 myself. But it must be done by personal work. You must go to the men. They do not know what the dues are; talk to them three or four minutes and they will find out about the Society and will be glad to join. We will not have any trouble in getting a thousand members.

Look at the sportsmen in Missouri. I understand they have an organization here now of a thousand members, and there ought not to be any trouble in getting a hundred of

those members to join this Society. There is not an organization in the country doing the grand work that this Society is doing; and certainly the sportsmen and the sporting goods manufacturers should help out; manufacturers of fishing tackle and implements should assist. We ought not to be in need of funds; we ought to have ten times as much money as we require.

MR. FEARING: We need more publicity.

TREASURER: Is there any objection to the general public attending the meetings?

PRESIDENT: No.

TREASURER: Then it seems to me that it would be a good idea for our Society, through its President or Chairman of the Executive Committee, or Secretary, to send out personal invitations to the members of the sporting clubs, boards of trade, etc., to attend our meetings. I have an idea that a great many members of sporting clubs would gladly attend meetings if they knew they would be welcome. If invitations are sent to these clubs a much larger attendance will be secured, and thus we will get new members.

MR. E. T. GREYER, St. Louis, Mo.: I would say that until a week ago I did not know anything about the meeting, and I would suggest that it would be advisable for the Society to have a committee on publicity, so that they would be able to send out advance notice of the time and place of meeting as well as something of general interest with regard to the meeting. I know it to be a fact that there is no state in the union but that has one or more sportsmen's associations; and the officers of those associations would be very glad without doubt to arrange something to interest the public, especially the clubs. In the city of St. Louis we have 185 clubs, and I would have sent some word to them of the meeting here, but I did not know anything about it until a short time ago when I made application for membership in the Society. I did not know where the meeting was to be held, and I merely put in the paper seven or eight lines mentioning that there would be a meeting on October 3. Mr.

Geserich, President of the Fish Commission, was out of the city and I could not secure any information from him. I would have gladly written more and the people would have been glad to read it. There are things that come up in the meetings that are of great importance; and I know the sportsmen of this city would have turned out gladly if they had known of it.

PRESIDENT: The question of a committee on publicity is important, and as further talk only consumes time and it is evident that this is the solution of the problem, I suggest that somebody make a motion that this matter be referred to the Committee on Resolutions with instructions to report recommending the creation of a Committee on Publicity, so we can dispose of the matter at once.

DR. FIELD: It seems to me it would be well to act in full meeting. It does not seem to me the function of the Committee on Resolutions to report on matters of general business.

PRESIDENT: I think we can dispose of it now.

MR. GRAHAM: Would it be better to do that or to add to the Committee on Membership and have the same committee act as both?

PRESIDENT: There is no Committee on Membership.

MR. GRAHAM: I think there ought to be.

PRESIDENT: It is understood that the whole Society is really a Committee on Membership.

MR. GRAHAM: I move that the President appoint a standing committee of three on publicity.

Motion seconded and unanimously carried.

ELECTION OF OFFICERS

PRESIDENT: We will hear from the Committee on Nominations.

DR. BEAN: The Committee on Nominations offers a unanimous report of names for officers and committees for the ensuing year. In making these nominations we have been guided by the rules which have governed the

Society heretofore, that is to say, the Vice-President is the candidate for the presidency, and the chairman of the Executive Committee becomes the candidate for the vice-presidency. All matters have been considered carefully by the committee and the names are offered now for your ratification.

President: S. F. Fullerton, St. Paul.

Vice-President: Charles H. Townsend, New York.

Vice-Presidents of Divisions:

Fish Culture: John W. Titcomb, Lyndonville, Vt.

Aquatic Biology and Physics: Dr. Edwin Linton, Washington, Pa.

Commercial Fishing: A. B. Alexander, Washington, D. C.

Angling: H. Wheeler Perce, Chicago, Ill.

Protection and Legislation: Dr. T. S. Palmer, Washington, D. C.

Treasurer: C. W. Willard, Westerly, R. I.

Corresponding Secretary: Dr. H. M. Smith, Washington, D. C.

Recording Secretary: Ward T. Bower, Washington, D. C.

Assistant Recording Secretary: Miss Ethel M. Smith, Washington, D. C.

Executive Committee: Dr. Henry B. Ward, Chairman, Urbana, Ill.; Daniel B. Fearing, Newport, R. I.; E. Hart Geer, Hadlyme, Conn.; D. H. Power, Suttons Bay, Mich.; A. R. Whitaker, Phoenixville, Pa.; R. Tyson White, Brooklyn, N. Y.; W. L. May, Denver, Colo.

Committee on Foreign Relations: Dr. H. M. Smith, Chairman, Washington, D. C.; E. N. Carter, St. Johnsbury, Vt.; Dr. George W. Field, Boston, Mass.; Dr. F. M. Johnson, Boston, Mass.; H. F. DePuy, New York; Dr. J. A. Henshall, Tupelo, Miss.

Acting upon the authority and with the consent of the committee I move the election of these officers and members of committees.

Motion seconded and unanimously carried.

The report was adopted and the persons recommended by the committee were declared elected as the officers of the Society for the ensuing year.

PRESIDENT: We will proceed to the discussion of Dr. Green's paper.

Dr. Green's paper was then discussed.

PRESIDENT: The next paper is by Mr. W. O. Buck, on "Control in Pond Culture."

The paper was read and discussed.

PRESIDENT: Before we take up the next paper I will announce the Committee on Publicity. I have taken advantage of the elementary prerogative of a chairman and have appointed myself as chairman of that committee.

As the other members of the committee I will appoint Mr. W. L. May, of Denver, and Mr. Ward T. Bower, of Washington, D. C.

PROFESSOR DYCHE: I move that when we adjourn we meet at our regular place at the Planters' Hotel at 8 o'clock this evening.

Motion seconded and unanimously carried.

PRESIDENT: The next paper is by Dr. H. B. Ward and is entitled, "The Distribution and Frequency of Animal Parasites, and Parasitic Diseases in American Fresh Water Fish."

The paper was read and discussed.

MR. BUCK: I would like to offer one suggestion, in connection with the Publicity Committee, before a motion to adjourn is made. I feel sure that when we have a good thing we cannot have too much of it, and without meaning in any way to reflect upon the very efficient committee that has been appointed, I wish to suggest that each one of us should feel it his duty to assist in every way he can toward the publicity of the cause and toward the procuring of new members. I want also to ask permission to add my friend here who suggested the committee, and talked upon it in a way which indicates that he will have a great deal of en-

thusiasm for the cause, and will be able to help it along. With your permission I move that Mr. Graham be added to the committee.

PRESIDENT: That is a very good suggestion.

The motion is that the committee be enlarged by the addition of Mr. Graham.

Motion seconded and unanimously carried.

PRESIDENT: Mr. Graham is added to the committee.

A recess was here taken until 8.00 p.m., at the Planters' Hotel.

The President called the meeting to order at the Planters' Hotel, St. Louis, at 8.15 p.m.

PRESIDENT: Gentlemen, Mr. L. A. Geserich, President of the Missouri Fish Commission, wants to say a few words to you in the way of extending an invitation.

MR. GESERICH: Mr. Chairman and gentlemen of the American Fisheries Society: I was saying to Mr. Bower a few moments ago, that I did not want to interfere with any prearranged plan that you gentlemen may have; but I do want to say this, that the State Fish Commission of Missouri recently secured a new distributing car, one equipped with every modern device for handling fish and water. I thought if you would like to profit by our experience and see what we have, we should be glad to have you visit the car tomorrow. I really think we have something that no other state has today, or even the Bureau of Fisheries at Washington, D. C., in the way of a fish distributing car—that is, so far as the water and air plans are concerned. If you can come out tomorrow afternoon we shall be highly pleased. It will take about 20 minutes to run out there. I shall be very glad to have you look the car over if you can.

PRESIDENT: What time will the car be on view?

MR. GESERICH: It is in storage at Compton Avenue yards. I will have the superintendent arrange to fill a number of the big tanks with water and obtain a supply of air. We can then make a demonstration, I think, that will

be of interest to all of you gentlemen. If 2 o'clock would be convenient tomorrow we could run out from here and not interfere with any plans you may have after that in the way of entertainment. I understand you are going to a place where they make a product in Missouri called beer. (Laughter.)

PRESIDENT: We had heard they did something of that sort in Missouri, and some of our members being of an investigating turn of mind wanted to ascertain just what it was, as they understood that the Missourians thought a great deal of the product. (Laughter.)

MR. GESERICH: I will say that I have gone down there frequently. You know I have a little fun once in a while as I go. I must get that fun myself, and if I don't grab it I lose. We make a few fish here and also have the biggest brewery in the world. When you get down there the brewery is yours, as far as your capacity is concerned while you are there. (Applause and laughter.)

PRESIDENT: I suppose, gentlemen, that if we push things lively we can finish by half past 12, and after luncheon we could visit the car and from there take up this other investigation. I think we will try and fix that as part of the program.

MR. GESERICH: I shall be glad to be here at 2 o'clock and will escort you to the fish car, and from there to the brewery. It will take 25 minutes to run from the fish car to the brewery.

PRESIDENT: We will be ready perhaps a little before 2 o'clock.

MR. GESERICH: Then I will be here before 2 o'clock.

PRESIDENT: Is the Auditing Committee ready to report?

SECRETARY: The chairman of the Auditing Committee handed the report to me. It is as follows:

St. Louis, Mo., October 4th.

We have examined the report and vouchers of the Treasurer and find them correct.

Signed:	S. P. BARTLETT	} <i>Auditing Committee</i>
	H. WHEELER PERCE	
	W. T. THOMPSON	

Report unanimously accepted and adopted.

TIME AND PLACE OF NEXT MEETING

PRESIDENT: I will call on the Committee on Time and Place of Meeting for its final report.

MR. DOWNING: We have decided that the time should be early in September, and as the first Tuesday comes on the 3d, the committee thought that this would be the most convenient time.

PRESIDENT: You hear the report of the Committee on Time and Place of Meeting. What is your pleasure in the matter? The full report as presented is, that the next meeting shall be held in Denver, Colo., beginning Tuesday, September 3, 1912.

Motion made and seconded that the report of Committee on Time and Place of Meeting be adopted as finally given.

Motion unanimously carried and so ordered.

PRESIDENT: We will now listen to a paper by Prof. L. L. Dyche, entitled "A New and Enlarged Fish Hatchery for the State of Kansas."

Professor Dyche then read his paper which was discussed.

Dr. S. P. Bartlett presented a paper on "The Decrease of the Coarse Fish, and Some of its Causes." The paper was discussed.

Adjourned to 9.00 a.m. next day.

Thursday, October 5, 1911, 9.55 a.m.

Meeting called to order at the same place by the President.

PRESIDENT: We will now listen to a paper by Mr. S. G. Worth, of Mammoth Spring, Ark., on "Fresh Water Angling Grounds for the Striped Bass."

The paper was read and discussed.

PRESIDENT: The next paper is by Mr. S. W. Downing: "Are the Hatcheries on the Great Lakes a Benefit to the Commercial Fisherman?"

Dr. Ward then read the paper by request.

Before reading the paper Dr. Ward said:

I am very glad to be of any service to my friend, Mr. Downing, especially because the paper was of considerable interest to me as I read it over at his request. Please understand that all this is to be attributed to him. I know he deserves it.

After being read the paper was discussed.

PRESIDENT: That embraces all the papers to be read by those present, and we will now take up Dr. Charles H. Townsend's paper on "The Pribilof Fur Seal Herd, and the Prospects for its Increase."

The paper was read and discussed.

Mr. Worth then read a paper, by Mr. J. F. Boepple, entitled, "Notes on the Fish of the Cumberland River."

PRESIDENT: The next paper will be, "Some Observations on the Culture of Yellow Perch in Ponds," by Mr. W. B. Gorham, of Erwin, Tenn.

The paper was then read.

PRESIDENT: The next paper will be, "Atlantic Salmon in Fresh Water," by Mr. Charles G. Atkins, of East Orland, Me.

The paper was then read by Mr. Thompson.

PRESIDENT: The next paper will be, "Notes on Some Seldom Marketed Salt Water Fishes," by Mr. John Treadwell Nichols, of New York City.

I will ask that it be read by Dr. Bean.

The paper was then read and discussed.

PRESIDENT: The next paper is one that I think I will have to ask our friend, Dr. Bartlett, to read, otherwise he

might feel hurt. The title is, "As to the Carp," by Mr. W. T. Hunt, Secretary of the Chester County Fish and Game Protective Association, West Chester, Pa.

DR. BARTLETT: I will ask to be excused.

PRESIDENT: Then I will give it to the next best friend of the carp, Professor Dyche.

Professor Dyche then read the paper referred to, after which it was discussed.

PRESIDENT: The next paper is on the subject of "The Taxation of Oyster Properties," by Mr. Henry C. Rowe, President of the New York and New England Oyster Shippers' Association, Groton, Conn.

I will ask Mr. Buck to read this paper.

Mr. Buck then read the paper.

PRESIDENT: I will ask Mr. Bower to read the next paper which is on the subject of "Notes on Pond Culture in the Philippines," by Mr. Lewis Radcliffe, Washington, D. C.

Secretary Bower, before reading the paper, said: Mr. Radcliffe is one of the assistants in the Bureau of Fisheries and is well qualified to write on this subject. While attached to the *Albatross* in the capacity of Assistant Naturalist he made an extended cruise through the Philippine Islands.

PAPERS READ BY TITLE

PRESIDENT: The Secretary is requested to read the remaining papers by title, with a view to their publication in the Transactions.

SECRETARY: The following papers presented have not been read:

"Trematode Parasites in the Skin and Flesh of Fish and the Agency of Birds in their Occurrence," by Dr. Edward Linton, Washington, Pa.

"Notes on Pond Culture at San Marcos, Texas," by John L. Leary, San Marcos, Texas.

"Future of our Brook Trout," by S. F. Fullerton, St. Paul, Minn.

"Some Observations on Rearing Sunfish," by J. J. Stranahan, U. S. Bureau of Fisheries, Bullochville, Ga.

"Licenses for Hook and Line Fishing," by Dr. T. S. Palmer, U. S. Biological Survey, Washington, D. C.

"Regarding Fishways and Dams," by Prof. L. L. Dyche.

"Experiments in Rearing Bass from No. 1 to No. 2 Fingerlings at the Mill Creek Station in Michigan," by Dwight Lydell, Comstock Park, Mich.

MR. BUCK: I move that the papers read by title by the Secretary be included in the printed report.

Motion seconded and unanimously carried.

PRESIDENT: We have had presented 22 papers; I think that the Society can congratulate itself on the high character of these papers. Nearly every one of them has been of very great interest and productive of discussions of great value to all.

We will now listen to the report of the Committee on Resolutions.

REPORT OF THE COMMITTEE ON RESOLUTIONS

The report was presented by Dr. Field.

DR. FIELD: The Committee on Resolutions unanimously recommends the adoption of the following resolutions:

Resolved, That this Society extends to His Honor, the Mayor of St. Louis, to the Honorable Commissioners of the states of Missouri and Illinois, and to their deputies and superintendents thanks for their hospitality and considerate attention to the Society and its members.

Resolved, That a vote of thanks and of appreciation be extended to our Secretary, Mr. Ward T. Bower, for his exceeding efficiency and courtesy in the performance of the duties placed upon him.

Resolved, That the thanks of this Society be extended to the management of the Planters' Hotel and to the press in St. Louis for the uniform courtesy and for the many favors extended to our members.

Resolved, That the Society records with sincere regret that death has claimed ten of our members during the past year:

Moses H. Cone, Greensboro, N. C.

Frank N. Clark, Northville, Mich.

Howard M. Buller, Bellefonte, Pa.

H. D. Chichester, Washington, D. C.
William Cutler, Comstock Park, Mich.
F. C. Zacharie, New Orleans, La.
J. W. Brackett, Auburn, Me.
E. A. Jaggard, St. Paul, Minn.
Arthur Sykes, Madison, Wis.
Edward Birbeck, London, England.

To the families and friends of the deceased members we hereby extend our deepest sympathy, and we request the Secretary to spread this resolution upon our records and transmit a copy to the respective families.

WHEREAS, in the sudden passing of Frank N. Clark, this Society has lost a member who, by industry, by intelligent enthusiasm, by honesty of purpose and essential integrity of character, has done much directly and indirectly to advance the cause of fish culture; and who, by his singleness of purpose, by his energy in surmounting obstacles, by consistent and insistent forcefulness of mind and body, patiently worked his way to the forefront in the ranks of fish culturists, and who, by helping others, unconsciously helped himself, and, above all, advanced the cause which he so ably represented, be it

Resolved, That while recognizing the beneficence of the Divine Will, we deeply deplore the loss which we have sustained; and further, that we appreciate sincerely the indescribable impress for good which the Society received through the presence of our late member and President; and be it further

Resolved, That a copy of these resolutions be transmitted to the family, to whom we extend our deepest sympathy.

Resolved, That this Society expresses its confidence in the importance of the work of the National Bureau of Fisheries, and respectfully urges upon Congress and upon the Honorable, the Secretary of the Department of Commerce and Labor, to furnish increased facilities for prosecuting the work of developing the productive capacities of our fresh and salt waters, in order that said waters may be operated as successfully, and yield annual crops of marine food comparable to the staple products of the farm. It has been amply demonstrated that under proper laws of tenure, freedom from pollution and adequate national and state protection, our inland sea and shore fisheries can be one of the nation's most important sources of food and wealth.

WHEREAS, That since fish and shellfish, which are of great value as human food if placed in the hands of the ultimate consumer in good condition, are subject to rapid postmortem chemical changes; and

WHEREAS, Much unnecessary uncertainty relative to the condition and previous treatment checks the sale of such food, resulting in waste to dealers and to consumers; and

WHEREAS, This Society deplores the lack of accurate and scientific data relative to chemical changes and the conditions under which they

occur, as is necessary to properly safeguard the interests of fishermen, dealers, distributors, consumers and the public health; be it

Resolved, That this Society urges upon Congress, upon the Bureau of Fisheries, upon the various states, and upon all competent individuals to enter upon an organized, unbiased, detailed investigation of the problems connected with the chemical composition of the various fish foods, the progressive chemical changes, and the toxic properties at various stages of decomposition together with specific applications of these facts to storage, distribution and sanitary utilization of these animals as human food.

WHEREAS, It has been found necessary for the successful maintenance of wild birds to set aside national and state reservations as breeding places, and

WHEREAS, Competent biological observation in European countries, and more recently in Illinois, Indiana, New York, California and Massachusetts, has demonstrated that in order to maintain an adequate population of fish in our streams and coastal waters, suitable and extensive natural breeding grounds must be maintained by national, state and individual initiative and action; therefore, be it

Resolved, That we urge the various states and Congress to take immediate action to acquire and to conserve such natural breeding grounds for fish, and to take appropriate measures for increasing the capacity of such breeding grounds.

WHEREAS, In spite of the fact that many organizations of nationwide influence have repeatedly urged attention to the enormous damage to public health and property by unnecessary and unwise methods of disposal of sewage and manufacturing wastes; and

WHEREAS, Many state legislatures have enacted wise laws for investigating these conditions and for conserving the public health and the public resources thus imperiled, for preventing the wholesale destruction of fish life, the restriction of areas naturally suitable for breeding places, and the ultimate ruin of the potential capacity of these waters for producing food for fish and fish for food; and

WHEREAS, It is notorious that in many sections of the United States the facile introduction of sewage and manufacturing waste into streams and coastal waters has hitherto checked the development of advanced methods for economic utilization of these waters; be it

Resolved, That this Society urges upon Congress, upon the legislative and executive departments of every state, and upon all good citizens, to thoughtfully act for checking the incalculably enormous wastes of nitrogenous material and of water, which, properly treated and distributed, would be more valuable upon farming land, and of many waste products of manufacturing which could at present or in the future be made of economic value.

WHEREAS, This Society deplors the large and increasing destruction of valuable food and game fish in the ditches of irrigation systems, and

WHEREAS, The recent and future great increase in the irrigation projects of our nation makes it a certainty that this loss will be greatly augmented thereby; be it

Resolved, That we urge upon the attention of state officials and legislative bodies in the regions where irrigation is practiced that they spread knowledge of the means by which such losses may be minimized or averted, and provide by statute for the introduction of such apparatus at the intake of ditches and canals, that the descent of fish into these artificial channels may be prevented. We deem this of great importance, not only that the sums devoted by the states and nation to the propagation and culture of fish should bring their adequate returns, but also that so attractive a feature of outdoor recreation and sport and so valuable a food material may be conserved to the people for its proper use; and further be it

Resolved, That the Society hereby instructs its Secretary to send a copy of this resolution to the Governor and to the Game and Fish Commissioners of the various states interested, and recommends this matter to be given due prominence in their next message or report.

WHEREAS, There is a difference of opinion relative to the methods most suitable for the conservation of the fur seal herd on the seal islands of Alaska, be it

Resolved, That we commend and approve the course of the Department of Commerce and Labor in its administration of the fur seal service, and we urge careful and continued study by competent naturalists of the Bureau of Fisheries, as to the habits of the fur seal and the conditions on these seal islands; and further, we definitely oppose the passage of House Resolution 277 as introduced into the first session of the 62d Congress.

Upon motion duly made, seconded and unanimously carried these resolutions were adopted.

DR. FIELD: The committee unanimously recommends the adoption of the following:

That the Secretary be empowered to sell at \$1 each the volumes of the proceedings, except the last anniversary volume, which shall be priced at \$2 per copy. It is further recommended that any library be allowed to purchase a complete series of volumes on hand at a discount of 25 per cent; also that volumes of which only a few copies are still on hand be not sold separately.

Upon motion duly made, seconded and unanimously carried, the recommendation of the committee was adopted.

MR. THOMPSON: Mention is made of copies not being sold separately. Now in case some member is short a few copies would it not be rather unwise to compel him to buy a complete series?

DR. FIELD: This is to outsiders. Members already have that right.

PRESIDENT: A provision was embodied in the minutes a few years ago that members should always have the right to purchase.

CONSTITUTIONAL AMENDMENT

DR. FIELD: The committee unanimously recommends that Article V of the Constitution be amended to read as follows:

ARTICLE V

ORDER OF BUSINESS

1. Call to order by President.
2. Roll call of members.
3. Applications for membership.
4. Reports of officers.
 - a. President.
 - b. Secretary.
 - c. Treasurer.
 - d. Vice-Presidents of divisions.
 - e. Standing committees.
5. Committees appointed by the President.
 - a. Committee of five on nomination of officers for ensuing year.
 - b. Committee of three on time and place of next meeting.
 - c. Auditing committee of three.
 - d. Committee of three on program.
 - e. Committee of three on publication.
 - f. Committee of three on publicity.
6. Reading of papers and discussion of same.
7. Miscellaneous business.
8. Adjournment.

DR. BEAN: I move that Article V be amended as recommended by the committee.

The motion was seconded and unanimously carried by the vote of 17 members present.

PRESIDENT: The amendment is adopted.

MR. GRAHAM: I want to say a word in appreciation of the work done by the Secretary. I doubt whether many members realize what the Secretary has to do, for I know a great part of the work is left for him. Now with the membership we already have and expect to have during the next year there will be an immense amount of work to be performed, and the Secretary should be aided as much as possible by the members. I think that every member whether present or otherwise should help do the work. If this Society is going to be enlarged and do any effective work it will take a good many people to do it, and a lot of people taking hold of a thing can make a grand success of it. If it is all left to one, two or three, it will not be a success no matter how able the officers are. I believe there is not a man here but would be willing to pledge himself to secure ten new members before the next meeting. It would not take much time. Each one knows the people who are thoroughly interested in the work and who are willing to take hold of it. I believe that everyone should either go to the Secretary or write to him for ten applications for membership. I understand there are to be some new blanks printed soon, a little different from the present forms. Everyone here should agree to take ten of these applications, and the rest of the members should be communicated with to see if they will not do the same.

You can see then it is only a little work for each one, and that wonderful results will be accomplished during the next twelve months. I want to urge everyone here to take some of this work off the Secretary; and if they have any new ideas that they think are going to benefit the organization to write a note to the Secretary embodying those ideas. They do not necessarily need to be adopted, but some of the suggestions will be good and can be acted upon. We need the advice of everybody, and we cannot do too much to help the Secretary carry out the work.

If it is possible to have the reports printed earlier, even if some additional money is required, I should be in favor of

having it done. It would be fine if the report of this meeting could be issued in the next ninety days. We are all anxious to take home and read these papers carefully. There is a great deal of meat in them, and if we wait ten or twelve months it seems like a long way off. So if there is any manner whereby the Secretary can have this work done more quickly with additional help, I think the Society should give him that help.

DR. BARTLETT: I agree fully with the gentleman who has just spoken, and I will say further that I will pledge ten members even if I have to pay for them myself.

SECRETARY: The remarks of Mr. Graham have been of great interest to me, and I want to express my appreciation of his considerate attention. The work of the Secretary is rather arduous at times, and any suggestions or help will be welcome upon all occasions. This summer the work was rather light for me as I was in Alaska four months. During that time Miss Smith, our Assistant Secretary, looked after the work of the Society in excellent fashion. I want to emphasize the fact that the position of Assistant Secretary is by no means ornamental.

It occurs to me that it will hardly be necessary, as intimated by Mr. Graham, to incur much additional expense in getting the report out sooner. Of course once in a while there may be a little outlay for clerical help if it is necessary, in the judgment of the Society, to rush the report out as soon as possible. In the present depressed condition of our finances it cannot be done very well this year. However, I will try to get the report out as quickly as possible. A frequent cause of delay in issuing the report is the failure of members to make prompt returns of proof sent for their inspection and revision. Occasionally it is necessary to write two or three times before getting a response. Also, if we exercise caution and care in getting out the report it takes a little more time than if we let things slip through. My policy is to have everything absolutely accurate if possible. For example, if there is any doubt as to the spelling of a

name in the membership list it is my plan to write and ascertain the correct spelling. The same idea is carried out with respect to every part of the report. Perhaps I have been going too much into detail in the matter. Any suggestions that may be made by the members in connection with getting out the report will be most welcome.

MR. GRAHAM: I do not believe the Secretary is going too much into detail. I think the report issued last year is the most magnificent one I ever saw, and I know it is appreciated not only by the members but by the public at large. Time is required to get out such a report, but I thought that possibly with additional help it might be done more quickly and put into circulation so that the people in general could know about it sooner.

PRESIDENT: I want to add a word with regard to the work performed by the Assistant Secretary, Miss Ethel M. Smith. I have had occasion to carry on quite a heavy correspondence with the Secretary's office, which, in Mr. Bower's absence, occurred between Miss Smith and myself. I know, therefore, something of the amount of work that she has done in collaboration with Mr. Bower. Her work has been fine and should be mentioned and praised and generally appreciated. There are few Assistant Secretaries that would work as cheerfully and to the extent that she did. I say this without any detraction whatever from Mr. Bower's work.

DR. BEAN: The Society has one handicap which should be overcome in some way, and that is the raising of funds in the intervals between meetings. We receive a certain amount of cash at the annual meeting, but between the annual meetings there is very little revenue except from sales of publications. This handicaps the Society in getting out its Transactions. If we could elect members by some other means than by vote at the annual meeting, we could certainly increase our funds and be able to get out the report much earlier.

PRESIDENT: That is a good suggestion. Very often in many organizations the executive committee is given authority to elect members subject to final approval by the organization at the annual meeting. I believe it would be good policy for this Society to do likewise. It will not be necessary to amend the Constitution, as the matter can be taken care of simply in the form of a motion.

SECRETARY: It is the plan from henceforth to require that all applications for membership shall be accompanied by the fee of \$2.00. We can make use of this money several months perhaps before a person's name actually comes before the meeting for election. In the event of failure of election it can be refunded. The plan that Mr. Willard and I have been talking over of soliciting funds ought to be of material assistance in wiping out the deficit which now confronts us. I believe that with the two or three schemes we have in view, this deficit can be practically wiped out before another meeting. Our plans together with the excellent suggestions of Mr. Graham in the matter of soliciting new members will, I believe, assure success in the undertaking.

DR. BEAN: Then if we can provide for the election of members without waiting for the annual meeting it will solve the problem. I move that the Executive Committee have the power to accept members subject to the approval of the Society at its annual meeting.

Seconded.

PRESIDENT: The motion is in effect that between meetings the Executive Committee shall have the power to receive members subject to the approval of the Society at its annual meeting.

Motion unanimously carried.

MR. THOMPSON: In view of the words of commendation unanimously approved by the Society, regarding the efficiency of the work of the Assistant Secretary, and in order that we may express our appreciation in more tangible form, with the consent of the chairman of the Committee on Resolutions, I move that a vote of thanks and of appre-

ciation be extended to our Assistant Secretary, Miss Ethel M. Smith, for the exceeding efficiency and courtesy shown by her in the performance of the arduous duties imposed upon her.

Motion seconded and unanimously carried.

PRESIDENT: Before we adjourn I would like to say one word. Last year we created offices known as the Vice-Presidents of Divisions. I fear that some of the members do not fully appreciate just what this means, and I would suggest, therefore, that during the coming year, when any of the members come upon matter that would be of interest to any one of the divisions it be communicated in substance to the Vice-President so that he can make his report intelligently at the annual meeting, covering thoroughly the particular subject he has in charge. This year no reports were presented, but the plan I have suggested should be the precursor of the sectional work at our annual meetings which will become more necessary as our membership increases. It is therefore to the interest of the Society for every member to be on the alert for suitable material for each of the five divisions. Anyone who has any matter with reference to angling ought to send it to the Vice-President of the section on angling, and so on with the other sections. Thus the material can be condensed and presented to the Society in concise and proper shape.

If there is no other business a motion to adjourn will be in order.

DR. BEAN: I move that we adjourn sine die.

Motion seconded and unanimously carried.

Adjourned sine die.

In Memoriam

J. F. BOEPPLE
EDWARD BIRBECK

J. W. BRACKETT
HOWARD M. BULLER

H. D. CHICHESTER

FRANK N. CLARK

MOSES H. CONE

WILLIAM CUTLER

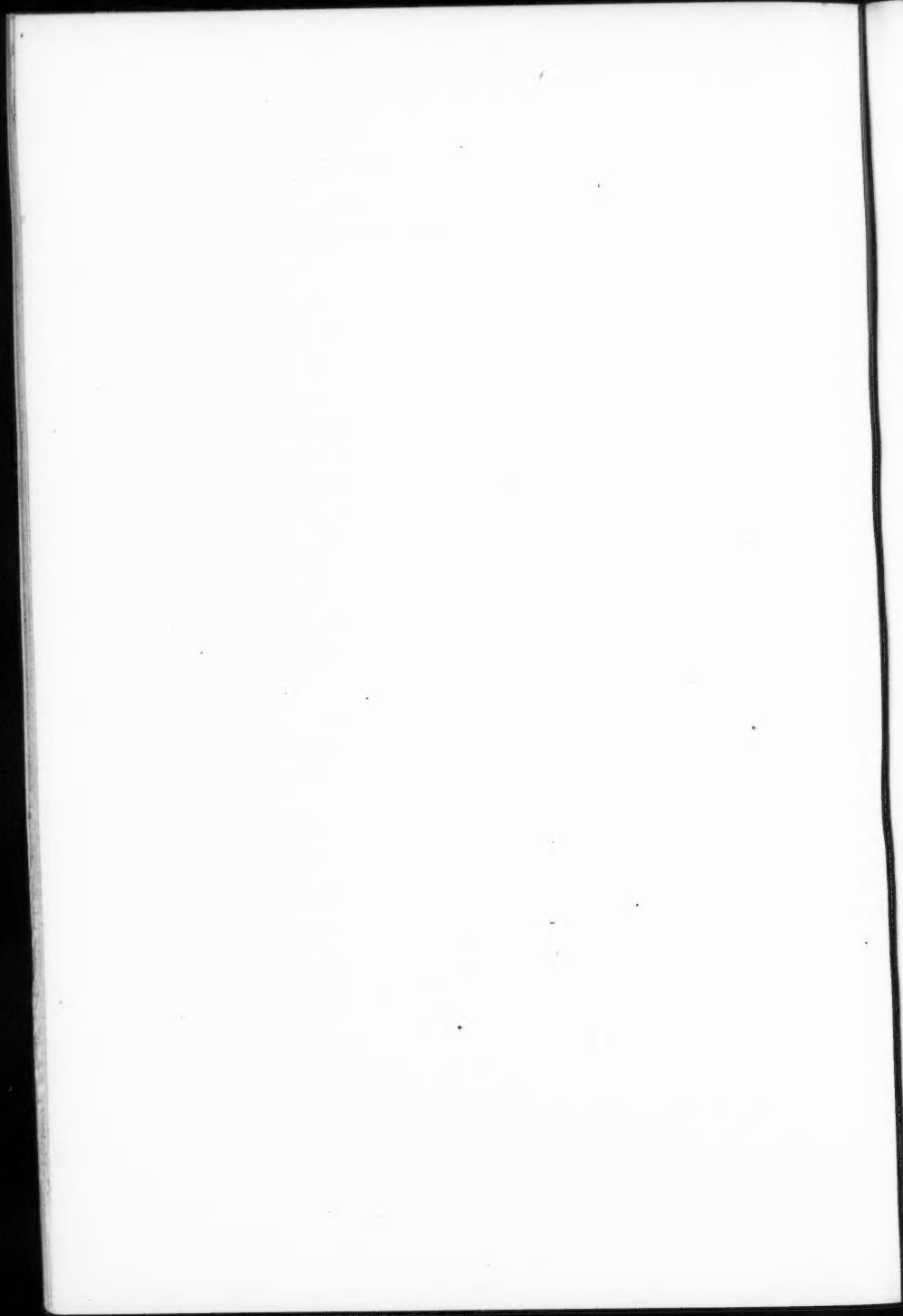
JOHN F. HILL

E. A. JAGGARD

J. L. LEARY

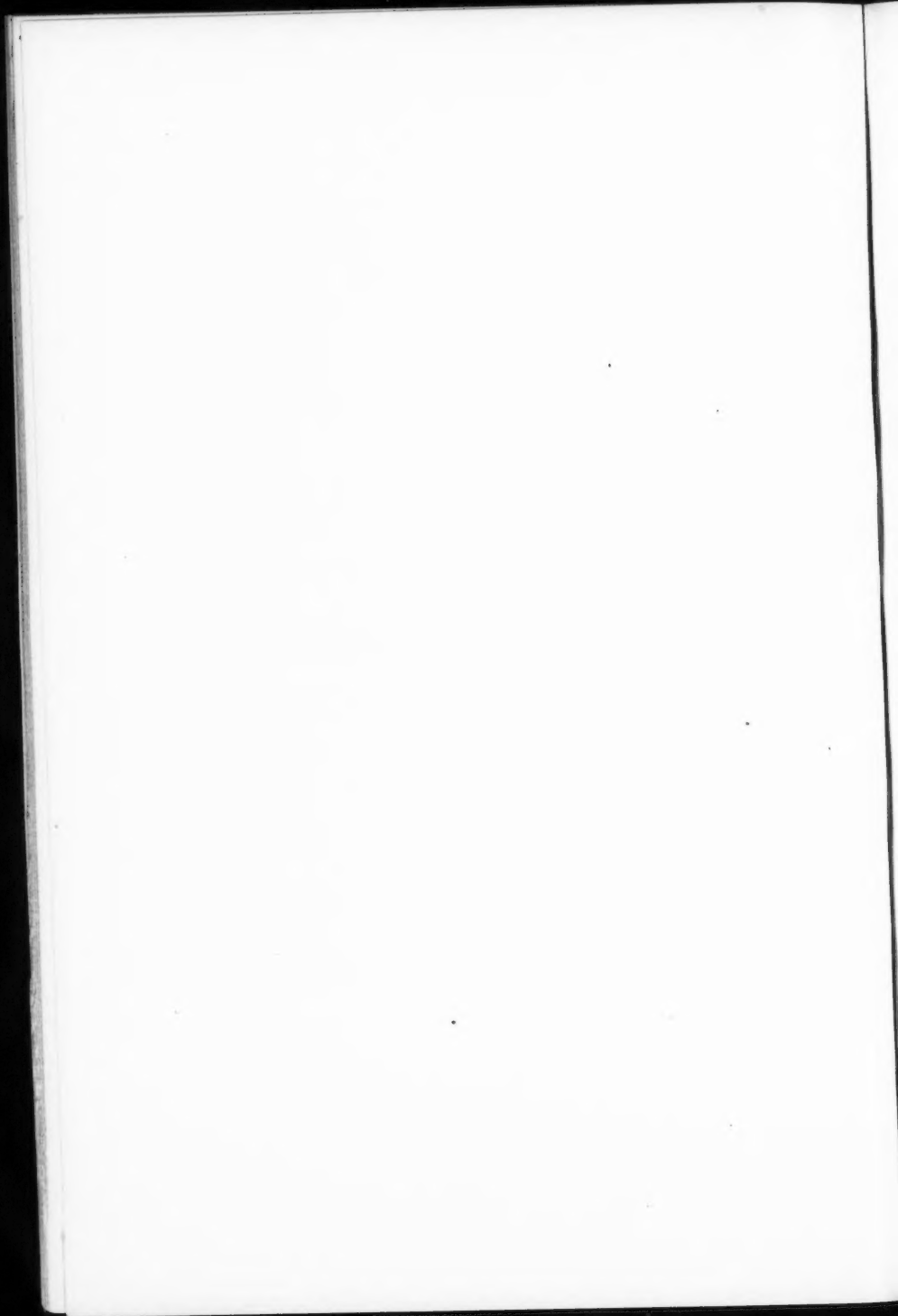
ARTHUR SYKES

F. C. ZACHARIE



PART II

PAPERS AND DISCUSSIONS



GOITRE AMONG TROUT, AND EFFORTS TO ERADICATE IT

BY W. E. MEEHAN

About the middle of February, 1908, the advanced trout fry in the hatchery at Spruce Creek, Pa., began to exhibit signs of uneasiness. Their movements were erratic and they took food languidly. The troughs were heavily laden with fish, with a flow of about three gallons of water a minute through each. In a few days it was evident that all the young trout, numbering about 2,000,000, were seriously sick, for they began to die in large numbers.

An examination showed the throat to be inflamed, and this was seemingly the immediate cause of death. At the time the disease was not considered necessarily fatal, because on transferring several thousand affected fish to outside ponds, the inflammation disappeared and most of them apparently recovered. Belief that the disease was not malignant was strengthened when it developed that advanced fry transferred to streams were later reported to have done well. There was also an almost immediate decrease in trouble after the troughs had been thinned. The cause of the disease was therefore thought to be overcrowding.

In the month of March following, when the trout had reached the size of no. 1 fingerlings, the disease appeared again, although not in as severe a form. There were less fish in each trough, but the same quantity of water was running through the troughs. On increasing the water supply by about half a gallon a minute, there quickly followed an improvement in the condition of the trout. Under the same conditions there was no recurrence, either in 1910 or 1911, in the hatching house.

Late in the fall of 1909, fungus suddenly developed among the two and three year old trout in the ponds, and it quickly spread among the yearlings. At least 20,000 fish

died. The appearance of the fungus was so sudden and the death rate so large, that it was thought best to draw the attention of the U. S. Bureau of Fisheries to the matter.

Mr. M. C. Marsh, the pathologist, arrived in a few days and after an examination declared the trout to be suffering from severe goitre, of a nature which an investigator in New York State had declared to be cancerous.

For many months prior to this, Dr. David Marine, of the Western Reserve University, Cleveland, Ohio, had been studying the character of goitre among trout under cultivation in Pennsylvania, with results which seemed clearly to indicate that goitre is not the first stage of cancer and further that cancer might not naturally be looked for to follow an attack of goitre. Under the circumstances, serious as was the situation at Spruce Creek, the diagnosis of Mr. Marsh did not cause the consternation it might otherwise have caused.

A few weeks after the visit of Mr. Marsh, Dr. Marine made an examination of the trout and confirmed the declaration of the former that the fish were suffering from enlarged thyroid. At least ninety per cent of the fish either had inflamed throats or fully developed tumorous-like swelling. The death rate was as heavy among the fish having only the first stage of the disease as among those in which it was fully developed.

Until then, there was no suspicion of any connection between the so called sore throat among the advanced fry in the hatching troughs and the fungused goitrous trout in the ponds; but the connection was quickly established. An examination of advanced fry in the hatching house showed that the inflamed throat was in reality the first stage of goitre.

Dr. Marine during his investigations proved clearly, what some of the superintendents and I had long believed, that the disease was developed by accumulated filth in the ponds. He also found that goitre followed overfeeding

with unnatural foods, overcrowding, and an insufficient water supply.

One year the hatching troughs were much overcrowded, the next there was an insufficient supply of water. The outside ponds were all clean and there was undisputedly a sufficient volume of water. The fish had, however, been overfed during the necessary absence of the superintendent, with the exception of a few short visits, from June until the first week in November.

That overfeeding was the principal cause was indicated by a curious but convincing condition. Beginning with number one pond, by the time number four was reached the supply of cut lungs and liver began to run short, and the fish in that pond therefore received not quite as much as those above. The same thing happened to the fish in number nine pond and number thirteen, and so on to the end. While there was some goitre in number four and the others in which the trout had been put on short rations, it was of small extent and there was less fungus and death.

Dr. Marine's investigations and the experiments of the superintendent at the Spruce Creek hatchery pointed out the remedy, and it was applied. A greater volume of water was run through the hatching troughs, the trout in the ponds were given several heavy salt baths, and the amount of food considerably lessened. Although the ponds were not believed to be overcrowded, the number of fish in each was lessened, and while cleanliness of ponds was the usual order of things, attention in this respect was redoubled.

It was not long before the trout began to show a decided improvement. Within a few months inflammation of the throat sank from ninety to less than fifty per cent, and by autumn it was hard to find a case of incipient goitre in the ponds. Old fish having the fully developed swellings of course still retained them, but to all appearances they were perfectly well.

There was not any "sore throat" among the young fish in the troughs last spring, and I never saw a healthier looking lot of trout in any fish hatchery.

DISCUSSION

PROF. L. L. DYCHE, Pratt, Kan.: What part of the throat did the soreness affect?

MR. MEEHAN: Right under the throat, just where the tongue rests; at the base of the tongue is where the inflammation first appears. It is of a pinkish color, an unnatural pink, that becomes deeper as time goes on, and then appears the swelling of the thyroid in cone-shaped lumps, sometimes found in the gills, and found at the point of the throat in quite a large number of instances.

PROFESSOR DYCHE: Does it break out—is there any raw place?

MR. MEEHAN: No, it is not raw; it is just like the tumor you see in the throat on the neck of a human being, excepting, of course, it is much smaller; it is essentially the same thing, apparently.

PROFESSOR DYCHE: Do you say that this leads to cancer?

MR. MEEHAN: I did not say that. I said that somebody else said so. On the contrary, the investigations that we made did not bear out the theory that goitre is the first stage of cancer or that cancer necessarily developed from it. Our investigations showed the reverse of that contention. But that it could develop into cancer and sometimes might so develop, was also apparent; but then it was just as a bruise that might develop into cancer. Because a fish had goitre it did not necessarily mean that the disease would develop into cancer.

The investigations were on these lines, that when a trout having a severe case of goitre was taken from the ponds and placed in a stream or water under different conditions, the disease apparently disappeared. To all intents and purposes the fish fully recovered its health. If that same fish were put back again in the pond from which it was first taken the goitre would reappear. Now, I am not a pathologist and I must therefore take the utterances of people who are. I have been given to understand that cancer is invariably progressive; it does not rise and become severe and then practically disappear, and then again become severe. But that is just what happens in the case of goitre; that is, it would entirely disappear if conditions were favorable. If we had goitre in our ponds to any great extent and it was traced, we will say, to overfeeding, and the amount of food was reduced to the proper quantity, the fish, excepting those with which the disease had gone too far, would get well. We never saw any fish die directly from goitre. We found that the fish died invariably from fungus, which was produced, presumably, by the lowering of their vitality because of the disease. Although we found no fish that died directly from goitre, I can understand that in some instances fish might die from it, because of the tumor so choking up the gills that they could not operate properly.

MR. FEARING, Newport, R. I.: Did you find that it came from overfeeding or from bad food? Was it not due to bad food?

MR. MEEHAN: Oh, no. Our food was good—it was always tested.

MR. FEARING: Accidentally you might have used decayed food, might you not?

MR. MEEHAN: No tainted liver, lungs or other food in the slightest degree improper, was ever put into the pond. Every piece was examined before being used. We were very particular about that, because we had some bad experience with feeding tainted meat.

MR. FEARING: That will bring fungus, if it is overfed, every time.

MR. MEEHAN: Yes, overfeeding will bring on the disease, and it was very bad in some of our ponds from that cause; but we found, as I said, that when the food supply was reduced, sometimes as much as one-half, and after thinning out the pond a little, the sickness disappeared.

MR. W. O. BUCK, Neosho, Mo.: I remember hearing the theory advanced that water once infected continued to breed the disease in other fish introduced into the same water. If I understand Mr. Meehan, his experience seems to contradict this; that is, when the water in the troughs and ponds was changed the fish recovered. Is my understanding correct?

MR. MEEHAN: That is right. Of course, I am speaking now solely of goitre.

MR. BUCK: Yes, that is what I had reference to.

MR. MEEHAN: Of course those fish that were fungused badly died, but some of those where the fungus had just started recovered when we used salt; but we never bothered ourselves much about trying to save fungused fish.

MR. BUCK: But if I understood you correctly, you succeeded in saving some of your young fish, or apparently so, by turning in more water, thinning them out, etc. Although they had shown symptoms of the disease they appeared afterward to recover from it.

MR. MEEHAN: This disease, which at the time they called sore throat, was brought to my attention by the station superintendents. This was in February, I think, or the early part of March, and we immediately began shipping those fish out, notifying the people who were to receive them, of the reason, and asking them to make special note of results. The majority of those who sent back word to us reported that the fish were doing very well; that for a short time after being put in the water they seemed languid, but in a little while appeared to be in first rate condition. A few died that were kept in small retaining ponds built by some applicants, so that they could observe the condition of the fish better. Possibly that might have had something to do with the loss, because perhaps too many were put in the small ponds; but I cannot speak of that authoritatively, not having seen them.

MR. BUCK: It seems to me that this point is a vital one to be determined, and I hope some one here may throw more light on it.

If it be true that water once infected will breed the disease in fish afterward placed there, evidently we cannot be too careful about turning out fish even only supposed to be infected. At the station where I am located there has been but little trouble with this disease, notwithstanding the fact that there have been a few cases and that it is necessary to keep the trout in the same ponds year after year. In order to hold them at all it is necessary to keep them close to the spring where they can have a good supply of cold water. Two years ago there were a number of infected fish. Last year we found but two and so far this year only one. Apparently the disease is diminishing in this pond. Perhaps complete draining of the pond each fall may affect the result.

MR. MEEHAN: I might refer to some experiences in other places in Pennsylvania. Dr. Marine's investigations indicated that with a change in water and a change in condition the fish recovered; and further investigations were rather against the likelihood of inoculation. However, his conclusions in that respect were by no means complete or satisfactory to him or to us.

One of the places in Pennsylvania in which goitre was exceedingly prevalent two years ago was that of the Blooming Grove Hunting and Fishing Club, a private club in Pike County. They had a hatching house and a number of ponds. I suppose 70 per cent of the fish, or at least a very large percentage, had the swelling of the thyroid in a very pronounced degree. You could pick up a net of fish out of a pond and you would find several of them in that condition. It was there that I sent Dr. Marine when he first came to Pennsylvania to study the subject.

It was found that apparently the chief cause of the goitre was filthy ponds. They were inexpressibly filthy; the faeces and the uneaten food would be simply washed down toward the lower end of the pond, toward the outlet, and would rest there 6 or 8 inches and perhaps more in depth. In fact, it was filthy all over the bottom of the ponds. But that condition has been entirely done away with at Blooming Grove. The ponds are kept clean and the food supply has been somewhat reduced, with the result that goitre has appreciably diminished.

There was another concern in the state, the Penn Forest Brook Trout Company, operating a commercial hatchery in Carbon County, but now out of business. A few years ago goitre prevailed there very plentifully—probably as bad as at the Blooming Grove Hunting and Fishing Club. I pointed out at the time that goitre, which was then commonly called "throat tumor," was caused by filthy ponds. It was found that the ponds contained from one to two feet and even more of inexpressible filth. They had not been cleaned in probably 12 or 15 years. The ponds were immediately drained off and cleansed, with the exception of two or three, and were kept clean thereafter, and goitre diminished very rapidly. I have been told that there is no goitre at Penn Forest now. But that seems to be rather improbable when

we consider that they have from 125,000 to 150,000 marketable fish. It is hardly likely that the disease was entirely wiped out, for in all probability when they said they did not have goitre in the ponds, they were referring to fish with the thyroid enlarged; they had not looked down the throat of the fish and seen the inflammation.

We also had goitre at the state hatchery at Bellefonte. It was due there, I believe, to overcrowding rather than to overfeeding (for those fish were not overfed), and perhaps to the ponds not being kept just as clean as they should have been, the superintendent having been ill for a long time. I started housecleaning there, and also thinned out the fish, with the result that the superintendent reported to me last spring that goitre had almost entirely disappeared. I went over the ponds again, netted fish after fish, using the dip net, and found scarcely any traces of the disease, although here and there I did find a fish that had a slight inflammation of the throat. Of course, I found any quantity of old trout that had the swelling, but the inflammation had gone.

DR. FIELD, Boston, Mass.: Did you say who the pathologist was who made the investigations?

MR. MEEHAN: Dr. David Marine, of Western Reserve University, and Dr. Leonard.

DR. FIELD: I asked that for this reason: When the question of the possibility of the disease being cancer came up I placed the matter in charge of the cancer hospital in Boston, in the hands of an eminent pathologist, a cancer specialist, Dr. E. E. Tyzzer, of Harvard Medical School, Boston. We had some difficulty in getting material, but we obtained it at last, and Dr. Tyzzer is at work on it. His report is not yet prepared.

MR. MEEHAN: I might say that the results of Dr. Marine's investigations were published in two bulletins by the Department of Fisheries of Pennsylvania. They may be had upon application. One was published last year and one this spring.

Q. Is it generally believed to be a new disease? I can recall it as far back as 1875. I remember when I was a small boy of seeing a trout in an old pond that showed unmistakable signs of this disease.

MR. MEEHAN: We have had it for years.

DR. TARLETON H. BEAN, Albany, N. Y.: Some of our stations in New York developed this thyroid tumor, notably the one at Bath, and before that the station at Cold Spring Harbor on Long Island.

Not being able to have the services of a competent bacteriologist or pathologist, we proceeded to change the water supply, because we believed that the origin of the throat tumor lay in impure water. Whether or not it does rest there, the changing of the water supply has eliminated goitre absolutely. Not a case of goitre has been reported for some years from either of those stations. It existed at Cold Spring Harbor 20 years ago at least, and caused the loss of many hundreds of brood fish. At Bath the loss was even more serious. It affected the brook trout and the brown trout more especially, but rarely involved the rainbow trout. A strange circumstance with reference to the spread

of the disease, however, was made known in Keuka Lake into which the hatchery stream flows some 4 or 5 miles below the hatchery grounds. A large whitefish brought up from Keuka Lake was found to have a large and well developed throat tumor, not in the usual site on the thyroid, but between the gill laminae, and on the cartilage from which the gill laminae spring. I don't remember the name of that cartilage, but that is where the tumor was located for the most part, and only a smaller one on the thyroid proper. Now, how was the disease caused in this whitefish? No one had planted anything except whitefish fry in that lake, and none of those for a great many years. It seemed to me that the fish we had liberated purposely or accidentally in the hatchery stream must have gone down into Keuka Lake and acted as a source of infection to other species. Of course I don't know,—one swallow does not make a summer, one whitefish does not establish a principle; but there was a whitefish, not reared in activity, not associated with the pond fish in any way, except as they may have gone into the hatchery stream and introduced the disease into this lake. It seemed to me from that fact there must be some means of spreading the disease in the water. An impure water supply appeared to originate it. As soon as we cut out that source of supply we got rid of the disease. And furthermore we found, just as you did, that fish liberated in a stream where they had a rapid flow and plenty of water, recovered to the extent of more than 50 per cent. Even the large fish would come back to us clean.

MR. MEEHAN: Dr. Bean's remarks about the whitefish remind me of another matter which would indicate the possibility of the disease being communicable in some way, and which perhaps caused me to say that in Dr. Marine's investigation, while he found that it was difficult to inoculate the disease, yet the results were not satisfactory to him or to me.

I have not made any investigation myself in regard to the matter, and therefore will not say that it is so, but it is said that the blue pike in Lake Erie are generally affected, or that large numbers of blue pike in Lake Erie are affected with the thyroid disease. I received that statement, I think, from Dr. Marine and others. I have meant to look into it and ascertain to what extent it was true, but have not yet done so.

It was also stated that along the shores of the Great Lakes that thyroid troubles were quite common among dogs and other animals which were in the habit of eating fish offal, and even among the fishermen themselves along the lakes. Whether there is anything in that or not, I am unable to say.

MR. W. T. THOMPSON, Fairport, Iowa: Did you have the same number of fish in each of those ponds always, and were the ponds in which the disease was most prevalent larger than the others?

MR. MEEHAN: The number of fish in the ponds depended on the size of the latter. In one series of ponds they were about the same size and

each pond contained about the same number of fish. They had originally, of course, been counted in at the average of about 1,500 to 2,000 to the pond. The fish in the ponds in which there was very little disease and in the ponds where the disease was quite prevalent might have been of the same age, because we found the same thing happening among yearlings, among two-year-olds and among three-year-olds—I would not say four-year-olds, because we had only one pond of four-year-olds. We had only two ponds of three-year-olds, but we had 7 or 8 ponds or more of two-year-olds, and 12 or 13 ponds of yearlings.

MR. THOMPSON: I think you did not understand my question. What I meant was whether you did not have fishes of practically the same age and number in the ponds.

MR. MEEHAN: They were practically the same as to number and age.

MR. THOMPSON: It is a fact, is it not, that the fish that were over-fed grew much more rapidly than the others?

MR. MEEHAN: The fish in each pond were all practically of the same size, because we sorted them very carefully. But the number of fish in each pond was about the same, taking fish of the same age.

MR. THOMPSON: In the beginning?

MR. MEEHAN: Yes, all the way through. Whether they were fingerlings, yearlings, two- or three-year-olds, we held about what we believed to be the number of fish capable of existing in health in that particular pond.

MR. THOMPSON: The point I want to bring out particularly from a fish-cultural standpoint is this: We believe, of course, that prevention is much better than cure. I am "from Missouri," and I have to be shown where good generous feeding of young fish is detrimental to them provided growth is not so rapid as to cause overcrowding of the ponds. Take two ponds, each containing 2,000 fish of the same age and size, feed the first lot twice as much as the other, and that lot of fish is bound to grow beyond all comparison with those fish fed but half what they will eat. Consequently, in the course of a few weeks or months, as the case may be, the first pond, while containing but the same number of fish, is going to be very badly overcrowded, and, of course, will then suffer all the consequences due to overcrowding, while the other one remains in a normal condition. You can't keep 2,000 fingerlings no. 6 in a pond intended for that number of fingerlings no. 3 or no. 4.

I believe Mr. Meehan spoke of this trouble as occurring at one of the hatcheries during the absence of the superintendent, and he likewise said that all food before being put in the chopper was examined, and the tainted parts excluded. Now, if the superintendent was absent and this condition came about, is it not possible that the men may not have been quite as careful as they should have been in excluding tainted food; or, on the other hand, it might have been kept a day or two too long before feeding and thus acquire a taint. Granting that the fish were overcrowded and fed tainted food, unquestionably such conditions would bring on disease, but if they were simply fed generously, had a

sufficient water supply, the benefit of clean ponds and plenty of range, I would hesitate to endorse any claim that the mere full feeding was the cause of the disease, since my own experience in feeding fish shows the contrary. At one period in life I was engaged in stock raising, and the same principle holds true there. I have found that in every instance when fish or young of any kind were fed generously and with a degree of intelligence and given proper surrounding, they were the very best of their kind. Our breeders of cattle, horses and all varieties of live stock are good, generous feeders, and they produce the finest specimens of the various kinds of stock they handle. My experience has been that when human beings, stock, fish or anything of the kind are underfed, you then bring about a condition that begets disease; also often when such conditions prevail you find other factors lacking, such as cleanliness, etc. I am not referring, of course, to any particular instance; this is a general statement. Most emphatically, I am not prepared to indorse any statement that generous feeding, with good food, will cause disease, provided all the other conditions are right. I think there are a number of fish culturists here who will bear me out when I claim that when fish are generously fed and thinned often enough—and that is very often when they are heavily fed—there will be produced a better fish, likewise there will be less disease and less death than exists among those that are underfed.

Some years ago I presented a paper along these lines before the Society, giving a detailed account of experiments conducted at Nashua, N. H., to ascertain the effect of feeding on growth and egg production. We found in every instance that those best fed made not only the largest rate of growth, but had the smallest death rate; while they likewise produced a very much larger number of eggs.

The fish I have reference to were the long yearlings, 18 or 20 months old. We found those given practically all the food that they would eat made a phenomenal growth and each one of the females—100 per cent—produced spawn. The average per fish being 900 and over. This is much more than we get out of our average aged brook stock.

We do not want it to be heralded about that this Society or any member of it believes the feeding of good untainted food in generous quantities—some might call it overfeeding—produces disease. We believe in prevention, therefore we believe in generous feeding to produce strong, healthy fish immune from epidemics, which will produce good results when placed in the public waters. I would like to hear from other fish culturists on this subject.

MR. MEEHAN: While it is possible, of course, that we have been mistaken, and the fish really were overcrowded, it is still peculiar that there should have been a less degree of disease in the ponds in which there had not been the heavy overfeeding. I might say that the overfeeding was to such an extent that it was beyond what the fish ate. Would not that naturally be supposed to affect the fish in the ponds below where one might expect that the unconsumed food might con-

taminate the water and spread the disease? But it did not. Of course the stuff was removed every day even there. It would wash down and was all taken out.

There was another suggestion about the tainted meat. Of course there is a possibility that there might not have been the closest attention paid to the inspection of the meat, but the presumption is that there was, because it was the man who was left in charge that inspected the meat, and not the man who had the fish in charge.

MR. THOMPSON: When the cat's away, the mice will play.

MR. MEEHAN: So that it does not naturally follow that carelessness in the one would mean carelessness in the other. It is exceedingly rare that we now ever find any tainted meat, for in the past we have thrown back consignments on the hands of the shippers because of their not being just what they ought to be. In the past we used to have many plucks affected by tuberculosis, but we have practically none of that any longer, because I suppose of the government inspection. The only trouble we have ever had of late years was where meat might spoil on the road. We have it coming now actually frozen when it arrives in the summer months, coming as it does in refrigerator cars. We use large quantities at our Bellefonte hatchery. The cost of food alone is \$1,200 a year, so that it pays the company from which we buy the meat to send it to us in good condition. If any quantity of it is shown to be bad at any time the whole shipment is returned.

MR. THOMPSON: It often happens that food spoils rapidly after being cut up. It is not the ponds through which floating particles pass that are contaminated, but those where the food refuse sinks to the bottom and collects in the corners; here you have contamination to a much greater degree than with the surface filth which passes off. My contention was and is that these fish which have been heavily fed are the best fish.

Now, by heavily feeding a lot of fish, I do not mean to *feed the pond*; I believe in feeding the fish alone. When fish have taken all they will eat, any additional food simply falls to the bottom and is properly termed: "Feeding the pond." I do not believe in or endorse this for a moment. If these conditions prevail, they certainly would and should bring disease and death. My contention in this whole matter is simply that young fish, say under a year old, cannot be over-fed, provided they have a plentiful water supply and good range—I mean in a practical way. Of course I do not claim that a man cannot stand at a pond and deliberately overfeed the fish.

MR. MEEHAN: I agree with you on that point. The disease appeared with greatest severity in fish over a year old out in the ponds. The fingerlings apparently all recovered, and they were not affected by the fungus at all. There was no trouble of any consequence among those fish. It appeared among the yearlings, and two-, three- and four-year-olds, and not among the very young fish. I am like you, a great believer in feeding fingerlings with all that can be gotten into their little bellies.

MR. THOMPSON: When they are past the yearling age they can be overfed when kept in confinement. There is no question about that. We always feed our fingerling trout fry generously three times a day.

MR. S. W. DOWNING, Put-in Bay, Ohio: One word in regard to the prevalence of goitre among fishes of the Great Lakes to such an extent that the fishermen themselves are affected by it. I was a practical fisherman myself for 25 years and have been associated with the work for the last 40 years, and we know that the fishermen usually eat about their weight in fish once every six months, but I have yet to see the first fisherman that was affected with goitre.

MR. MEEHAN: I am glad Mr. Downing can back up my unbelief in the story; I did not believe it myself.

DEFINITE RESULTS OF SURVEY WORK ON THE ILLINOIS RIVER

BY STEPHEN A. FORBES

My excuse for appearing before you is that I am conducting a Natural History Survey of Illinois, under authority of the State Legislature and by virtue of appropriations from the state, with instructions to give especial attention to subjects of educational and economic importance. In this survey work, we have been, during the past year, giving particular attention to the aquatic life of the state, and especially to that of the Illinois River; and we have brought out some rather definite results which have such a general and important bearing upon the whole science of fish culture and the conservation of the resources represented in the principal rivers of the country, that I think it worth while to call your attention to them.

One of the things we have undertaken to do is to learn as much as possible of the breeding grounds and habits of some of the more important fishes. For that purpose I have had upon the breeding grounds of the fishes of the central part of the Illinois River, during the breeding seasons of the last two years; two men—Mr. R. E. Richardson, with Mr. H. C. Allen as his assistant—who have fairly lived in a boat, going over the grounds where fishes were depositing their eggs, where the fry were hatched, and from which the fry must escape if they were to survive. Their object was to learn everything possible with regard to the whole process, and also to determine what was the fate of the eggs and what was the fate of the fry. I cannot give you full details, but will mention two facts.

The carp is the most abundant fish in the Illinois River, giving us \$412,000 of income in 1908, while all the other fishes together gave us only \$309,000. The most important breeding ground for the carp which we have found on the Illinois River is an overflowed field which was commonly in

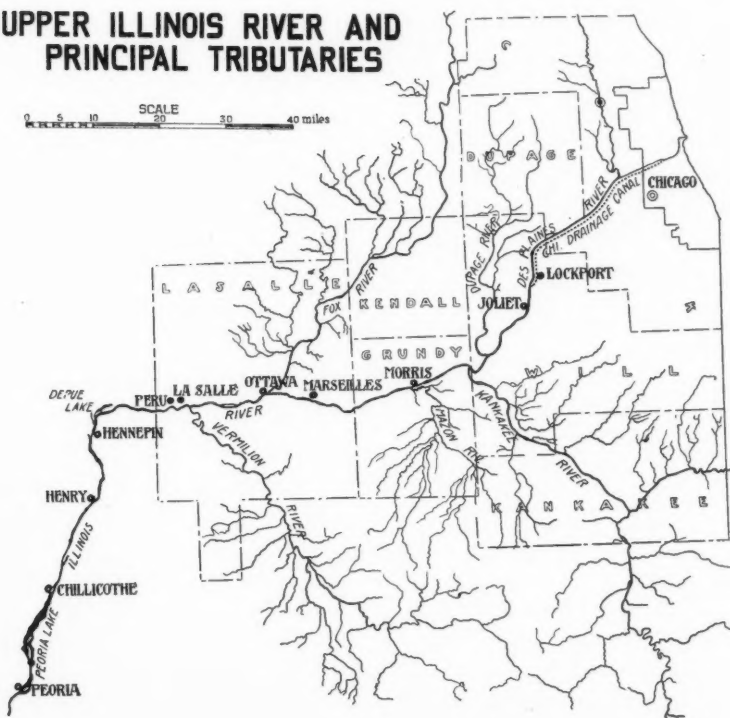
corn before the Chicago Drainage Canal was opened, and which is now under water during the greater part of the breeding season of our Illinois River fishes. In this field Richardson found that about 1,500,000,000 eggs were deposited on something like 600 acres of area. This number was arrived at by counts of the eggs on carefully selected measured areas, multiplied by the ratio of the measured surfaces to the total acreage on which eggs were deposited. Approximately 90 per cent of this billion and a half of eggs were killed by fungus infection in 1910, and so failed to develop. In 1911 the water of the river was unusually low, and only about 300 acres of this tract was covered at the breeding season, but the percentage of eggs destroyed by fungus infection was even greater than that of 1910, amounting, by Richardson's counts and estimates, to 98 or 99 per cent. It was noticed that where an egg lay in contact with a bit of rotting vegetation or other decaying debris, it was almost certain to be fungused; but where the water was comparatively clear and clean, and the weeds were fresh, practically all the eggs hatched—a point of special importance in view of its bearing on the care and management of both natural and artificial breeding grounds of fishes. The saprolegniaceous fungi which kill the eggs and the young fry of fishes, and sometimes older fishes as well, live primarily upon dead organic matter in the water, and do not require a living host; and they can be conveyed from the dead organic matter in the water to the living eggs or the living fry.

One result of our season's work was to confirm an opinion which I have had before that the productivity of the principal waters of the state can only be maintained and developed when the state gets control of certain selected important breeding grounds of the most important species, and takes care of them as it would of any other property; that it will not do to leave these matters to mere chance.

Another thing of particular interest is the fact that we found many nests of large-mouth black bass in the breeding

waters supervised; and that here also it depends largely on the surroundings of the nests and on the course of events, whether the eggs shall hatch or become fungused. The black bass prepares its nest in advance, sweeping off the rubbish and laying bare the roots of the water plants among which its nests are commonly placed, and its eggs are much less subject to destruction in this way than the eggs of the carp, which are thrown out indiscriminately and without previous preparation. Furthermore, as we all know, the black bass takes care of its nests and looks after its fry at first, so that the bass has a great advantage over the carp in respect to the survival of its young.

UPPER ILLINOIS RIVER AND PRINCIPAL TRIBUTARIES



Apparently as a consequence, the product of black bass, according to the United States census of this year, has risen from \$11,000 for the Illinois River in 1899 to \$58,000 in 1908, when the census statistics were obtained.

That perhaps is enough for that branch of the subject.

I made last year a statement with regard to the plankton production of the Illinois River under existing conditions as compared with those that obtained before the opening of the Chicago Drainage Canal. I simply said to you at the New York meeting, I remember, that the plankton product was larger now than it used to be before the Chicago canal was opened, bringing in an enormous amount of lake water and sewage. We now have our data in more definite form, and can compare the plankton product per cubic meter of the water of the river before and after the opening of the drainage canal. We found that the product was between two and three times as great per cubic meter of the water of the Illinois River in 1909 as it was before that canal was opened; and the bass fishery and the carp fishery, and the product of the whole river system, have risen in something like a corresponding ratio. I have some statistics here which I will not trouble you to read, but will pass that point with the general statement just made.

Now it might seem that we could rest content with the present condition of things, so far as Chicago sewage and the drainage canal are concerned; it might seem that it was like looking a gift horse in the mouth to go further. Nevertheless, I thought it my duty to look into the horse's mouth—to see, that is, what the conditions are where the drainage canal empties into the Illinois system; and the greater part of our work this season has been directed to that point. R. E. Richardson, biologist of my staff, and C. H. Spaulding, chemist, worked during midsummer from station to station on the upper 93 miles of the Illinois, from its origin at the junction of the Kankakee and the Des Plaines to the upper end of Peoria Lake.

The Des Plaines River comes down from the north practically parallel with the shore of Lake Michigan, and receives the drainage canal from Chicago between Lockport and Joliet. Our observations were directed to ascertain what were the conditions in the drainage canal and in the Des Plaines River at the mouth of that canal, at the mouth of the Des Plaines River after the natural waters of the Des Plaines and those of the drainage canal had mingled; at the mouth of the Kankakee, where we had as near the natural Illinois River water as we can now get; and then in the stream below the union of these two rivers to form the Illinois itself.

We found a remarkable contrast between the waters of the Des Plaines River and the drainage canal where the two came together, and not the kind of difference one might expect. The canal water was comparatively clean and clear to the eye, the highly dilute sewage it contained being still too recent to have undergone any very important part of its decomposition.

The Des Plaines River, on the other hand, was loaded, just above the mouth of the canal, with sewage products in an advanced stage of decomposition, and contained also an immense quantity and considerable variety of the organisms which live in impure water and cannot continue for any great length of time in water which is not contaminated. These same organisms, of course, characterize the water of the Des Plaines below the mouth of the canal.

The marked difference between these two waters was accounted for by the fact that the Des Plaines, as it came down from the north past Chicago, was receiving, undiluted, the sewage of a number of large suburbs of that city. Its current was slow under the low-water conditions of last summer, the weather was very hot, and the stream was shrunk by drouth. The sewage had consequently, time to reach an advanced stage of decomposition and to develop immense numbers of septic organisms before it reached the mouth of the canal; whereas, in the water of the canal

itself the sewage was still in a comparatively fresh and recent state, as was shown by its still recognizable ingredients, such as lumps of tallow, chunks of human excrement, pieces of toilet paper, watermelon and muskmelon seeds, broken grains of corn and wheat, and finely chopped straw—all coming down practically unaltered through the whole length of the canal. There was some development of the characteristic organisms of decomposing sewage, but in an insignificant amount as compared with that of the Des Plaines. There were even some lake fishes in the drainage canal, one a lake minnow represented by several fishes still living, but in a dying state.

Immediately below the mouth of the canal we have in the Des Plaines a mingling of these waters, and in the Illinois River itself, below the junction of the Des Plaines and the Kankakee, the septic contributions of the former stream are largely diluted by the comparatively clean water of the latter. Nevertheless, we had in July and August, what may be called septic conditions for twenty-six miles of the course of the Illinois from its origin to the Marseilles dam. At Morris, which is on the middle part of this section, the water, July 15, was grayish and sloppy, with foul, privy odors distinguishable in hot weather. The current was about four miles an hour, and the stream was in many places bubbling with gases arising from the bottom. Putrescent masses of soft, grayish or blackish, slimy matter, loosely held together by threads of fungi, and densely covered with bell animalcules, were floating down the stream; and chunks of this material, from the size of a walnut to that of a milk pan, occasionally rose to the surface, evidently borne up by the gases developing beneath them.

The gases from the bottom sediments of the stream were obtained for analysis, and were found to be identical with those from septic tanks of sewage systems, composed of the same elements present in similar ratios. When the analyses of these river gases were brought into the same table with those of gases obtained from the sludge in septic tanks of

Illinois towns, it was impossible even for an expert to tell which of them came from the sewage system and which from the Illinois River at Morris and Marseilles.

The gases of the water itself are, of course, more essential, since it is upon these that the fishes must depend for respiration. We found that at Morris the dissolved oxygen of the water amounted to an average of 9.8 per cent of saturation, the ratios ranging from $\frac{1}{2}$ per cent to $3\frac{1}{2}$ per cent of saturation July 22, and from 9 per cent to 21 per cent from July 28 to August 31. By "saturation" we mean the amount of oxygen which the water will take from the air by simple contact with it, so that oxygen equilibrium is established between the air and the water. Sometimes the water will contain an excess of oxygen, through living plants immersed in it and giving off oxygen in the sunlight. When we found at Morris the ratios of gas mentioned above, we found in the waters of the Kankakee, nine miles above, 112 per cent of saturation. There was more oxygen there than the water would take directly from the air. These comparisons show that from $\frac{5}{6}$ to $\frac{99}{100}$ of the oxygen of the river water was being used up, at this time, by decomposition processes going on within it at this point.

There were, of course, no fishes here, or any other animals requiring oxygen. Fishes were abundant in a small tributary of the river at Morris known as Mazon Creek, and in a slough at its mouth. Carp were especially numerous in this slough, but they did not venture into the river under these midsummer conditions.

Going down the river from Morris sixteen miles to the first dam crossing it, at Marseilles, we found an average of only 7.5 per cent of oxygen-saturation, and, of course, there were no fishes anywhere in this section of twenty-six miles. At the Marseilles dam the water had a fall of from 12 to 14 feet, and above this dam, of course, there was a semi-stagnant pool through which the water flowed very slowly. This pool served as a kind of settling tank, such that the larger organic particles fell to the bottom and the water went

over the dam comparatively clear of sediment. Such suspended organic materials as continued in it were pulverized at the dam and the water was thoroughly mixed with air, so that an eighth of a mile below, instead of the 7.5 per cent of oxygen found above, Spaulding's analyses gave us 65.4 per cent. A large part of this was really contained in air mechanically mixed with the water but not actually dissolved; but three-fourths of a mile below this free air had escaped, and the permanent content of dissolved oxygen there was 24.8 per cent. From that on down the river as far as we went the dissolved oxygen increased, under ordinary conditions, until, at Chillicothe, the lowest point at which we made collections, a maximum of 49 per cent was reached. Notice, now, that at the lower end of this ninety-three mile section of the river, we obtained less than 50 per cent of saturation with oxygen, while just above the upper end, in the mouth of the Kankakee, we got 112 per cent, showing that the water did not return to anything like its normal stage of oxygen saturation through these ninety-three miles.

To this rather long and complex account I will add only a remark or two as to the effect of these conditions on the fish life of the stream.

In the first place, the upper twenty-six miles of the Illinois was at this time practically a great septic tank for the city of Chicago and its suburbs. Our studies were made, however, in a season of continuously low water and unusual heat. What the facts would be under other conditions it will take further investigation to determine. At the foot of the dam below Marseilles, where the water has been aerated and partially purified, carp are said to appear almost continuously, and black bass are caught here occasionally. Notwithstanding the deficiency of oxygen, fish were found all along down the stream in increasing numbers as we went farther south. Fortunately, the upper end of this river is not the fish-producing end. There were some minor fisheries here originally, but all the important commercial fishing

is now carried on far down the stream, the first important point being Hennepin, fifty miles below the mouth of the Des Plaines.

DISCUSSION

DR. GEORGE W. FIELD, Boston, Mass.: Did you make any observations on the rapidity of nitrification in the stream?

DR. FORBES: We did not.

DR. FIELD: What is the condition at the dam at the mouth of the Kankakee?

DR. FORBES: There is an unfinished dam at the mouth of the Des Plaines. Some years ago the Economy Light and Power Company began to build a dam at this point with a view to creating a water power there, but litigation arose in resistance to this procedure, and the work was stopped and the dam remains unfinished. It extends effectively across a part of the stream, however, and thus acts as a wing dam to concentrate and to hasten the current of the Des Plaines, throwing it with some force to the other side of the Illinois, and mixing the waters of the Des Plaines and the Kankakee more thoroughly than would be the case if they were allowed to flow down gently side by side. They are not completely mixed, however, even as far down as Morris, some nine miles below, as was shown by a comparison of the oxygen content of the water at the two sides of the river. That which would naturally be Kankakee water, if left uncontaminated, contained, at Morris, twice as much oxygen as that from the other side of the river, corresponding to the Des Plaines. Nevertheless, this mingling of the waters and consequent dilution of the sewage content doubtless works to the advantage of the stream by bringing about a more rapid decomposition of its organic contents than if its sewage-laden waters flowed down undiluted, side by side with a comparatively clear current.

One other point of special interest, to which I have not alluded, came out in the course of our analyses. At one time during this period a heavy rain fell which brought the river up at Morris some six or eight inches. Fortunately, we had begun our chemical determinations some time before this rise, and we continued them through it and for a considerable time thereafter, so that we were able to see what the effect of these flooding rains was upon the oxygen content of the water of the river. This went down about 50 per cent the whole length of the stream as a consequence of this flood, the difference between the former oxygen content and that after the rain growing greater as we went down the Illinois, so that it was greatest at Chillicothe.

This was a rather surprising fact. Here was a great and sudden afflux of flood water which one would suppose to be comparatively free from organic matter, in which, consequently, there would be little decomposition in progress, and the oxygen content of which would

hence be much higher than that in the water of the stream itself. (There is little oxygen in waters loaded with organic contaminations, because the oxygen is used up by the processes of decomposition.) It was evident, from the facts, however, that the general flooding and scouring of the surface of the country, the washing off of the streets of towns, and the flushing out of sewers, which results from a heavy rain, brought into the river water containing larger ratios of organic matter than the stream itself, so that the stream became more heavily contaminated by reason of these flooding rains.

Now I have noticed, and most of you have no doubt had similar experiences, the occasional occurrence of what may be called epidemics among the fishes of our rivers in midsummer. Several cases have been reported to me where fish were dying in myriads along the course of a river in hot weather, piling up in rows along the banks of the stream in a way sometimes to create a great nuisance, requiring, perhaps, the active work of health departments to dispose of it. I remember, for instance, some years ago that it took a considerable number of wagons three days to haul away the dead fish that lodged on the bank of Rock River where it flows through the town of Rockford. All these occurrences come, so far as I have noticed, in hot summer weather followed by a series of heavy rains—especially violent thunder storms—which wash off the country and wash out the sewers, and overload the streams with organic debris, the decomposition of which must take the oxygen out of the water.

Quite lately there has appeared in one of the European fisheries journals an article reporting the investigation of just such an occurrence there. The writer of this article was fortunate enough to be on the ground at the time, competent to investigate it thoroughly, and with the necessary facilities at his command; and he found what I have supposed heretofore to be the case—that the oxygen content of the water of the stream in which the fish had died by myriads fell off almost to nothing, so that the fish were simply suffocated there by reason of the consumption of the oxygen of the water in the decomposition of the organic matter carried in by this hot-weather flood.

PROF. L. L. DYCHE, Pratt, Kan.: I think the Society owes about three votes of thanks for this most elegant address. I would like to comment a little on this paper, but I do not know in beginning whether to go forward or backward.

Speaking about floods, I have had three or four cases reported to me during the past summer—we had hot weather in Kansas, followed in certain localities by heavy rains—where people insisted that after a heavy thunder storm, water spouts, etc., lightning had struck the water (four or five cases were reported) and killed tons of fish. We had no faith in the contention, but answered by saying we thought it was the bad condition of the water; the exact explanation we could not give, as we did not visit the localities and did not fully understand the conditions. However, Dr. Forbes' paper has thrown much light on

the subject; and when we hear of lightning killing fish in the future, the information in this paper will enable us to give more reasonable information on the subject.

We have prepared a bulletin primarily for the people of Kansas, on "Ponds, Pond Fish and Pond Fish Culture." Part I on "Ponds" and Part II on "Pond Fish" are already published. Any of you gentlemen can receive these bulletins and have your names placed on the mailing list. We will send them to you if we can secure your correct addresses. If you do not receive them please let us know.

We have made some observations that have been recorded in these bulletins. The observations include some notes on rock bass that were spawning near the shore, where the swamp grass hung over near the places where the fish spawned. Many of these nests were only a foot from the shore in water not more than six or eight inches deep; and a very considerable number of these rock bass made nests where more or less dead vegetation such as grass and leaves existed. The fish would hollow out a place and deposit their eggs on the dead leaves, grass, etc., but only a small percentage of the eggs hatched. In fact, in some instances all the eggs would be covered with fungus. It bothered me a great deal to know why the eggs died in so many instances.

We read the reports of this Society and got much information concerning the spawning habits of the black bass and other fish. We do not have small-mouth bass in Kansas. We have undertaken to raise the small-mouth and it does well in the ponds, but if these fish are placed in our waters in competition with the large-mouth bass they disappear. I do not know what happens, but they disappear. At Lake View, near Lawrence, Kan., the government stocked 150 acres with small-mouth black bass some 15 years ago.

We have fished in that lake more than thirty years and never caught but one small-mouth black bass. This lake has always been well supplied with the large-mouth black bass, but the small-mouth black bass does not seem to thrive in the same waters in Kansas that are well adapted for the large-mouth variety. We notice in the reports of this Society that special gravel beds have with more or less success been prepared for the use of the black bass during the spawning season. We prepared a number of beds for black bass to spawn on. We wanted information suitable to and in harmony with the conditions of our own state. Many farmers in Kansas are raising fish and want information in regard to pond fish culture. Coarse sand and gravel was placed in these beds, the gravel ranging from the size of peas to marbles. These sand and gravel beds looked good enough to attract any spawning bass. Did the black bass come and spawn on those beds? No. They went just outside of the beds, where moss, grass and other small water-plants grew. They removed part of the grass and moss and the softer mud. In these shallow basins, lined with stems of grass and moss and their roots they deposited their eggs. Not a single bass, so far as observed, spawned on the gravel beds. These beds may be all

right for some localities, but bass in Kansas streams and lakes do not seem to care for such spawning beds.

Thus far all the bass beds we have seen have been in places where some vegetation grew, and the beds were lined with fine roots and pieces of growing vegetation. The material in the beds looked as though it had been wallowed or washed down to conform with the outline of the basin-shaped beds. On the strings of moss, roots, etc., the eggs had been deposited and could be seen adhering to the moss and grass roots. When the weather was favorable nearly all these eggs hatched. Where grass had been allowed to grow from two to four feet high along the shore for protection of young fish and had not been removed, a certain amount of dead material, such as leaves, grass stems and other matter, was found in the nests. In such places, where the water was clear enough to make observation, it could be seen that from 25 to 75 per cent of the eggs were affected by the white fungus. We did not know it was on account of the dead leaves and grass; however, Dr. Forbes has given us most valuable and much needed information on that point. Knowing that it is a bad thing to allow this dead material to accumulate where spawning beds are to be made, such material can be removed in time so that it will not do any harm.

We allow swamp grass to grow 3 to 5 feet high along the edge of the ponds for two purposes, one to keep the waves from cutting the banks when the wind blows hard, and the other is to protect the young bass that come to the edge of the ponds to feed. The young fish feed for the most part during the morning in the grass, moss and weeds that grow near the shore line. During the heat of the day they disappear and apparently go to hiding places among the water plants in deeper water.

The ponds at the Kansas state hatchery are all well stocked with goldfish. We put them in with the bass, crappie, bullheads and bluegills. It seems impossible to raise enough goldfish to supply food for the other fish. Bass seem to be very fond of goldfish. Old bass will eat them apparently in preference to almost any other kind of food. Something like 5,000 goldfish from 3 to 6 inches in length were placed in a pond during the spring with about 250 spawning bass. When the pond was drained early in September we found only four old goldfish. However, during the summertime we saw many young goldfish along the edge of this five-acre pond. We also bred crappie in the same ponds with large-mouth black bass.

About 100 giant crappie were placed in a five-acre pond with about 250 black bass. When the pond was drained in September it yielded over 30,000 young crappie and over 20,000 young black bass. Many of the young bass were from 4 to 7 inches in length. The larger specimens were feeding upon the smaller of their own kind and upon the young crappie. When we killed almost any specimen of the larger young bass, a smaller bass or one or two young crappie would be

found in its stomach. This pond was full of growing vegetation and it was not possible to handle or separate the fish until it was drained. However, we got over 50,000 young fish from it.

During the spring many goldfish also spawned in this pond. They came within from 6 to 15 inches of the shore to spawn. They seemed to be afraid of the bass and observations went to show that they had good reasons for their fear, for the bass were seen swimming near the shores watching for them. When a goldfish was thrown in the water a few feet from the shore it was usually grabbed by a bass. The goldfish had little roadways in the moss near the shore where they traveled, and along these roadways in the fine grass and moss they deposited their eggs. Soon after the goldfish eggs hatched, schools of little bass could be seen using these same roadways, and the little goldfish began to disappear. Examination of some young specimens of bass went to show that they were not only feeding upon young goldfish, but were eating their own kind. Young bass seem to begin to feed upon one another when they are scarcely two inches long. One of the serious problems about black bass culture at the Kansas hatchery is the cannibalistic nature of the young and growing stock.

MR. MEEHAN: I do not want to go on record as saying positively that fish will or will not be killed by lightning, but I would like to give two bits of experience that I have had as showing that under some circumstances at least fish may be killed by lightning.

PROFESSOR DYCHE: I am not positive on the subject, for I always doubted the lightning theory.

MR. MEEHAN: A few years ago at one of our hatcheries at Allentown, since abandoned, we had some ponds containing brook trout, others containing rainbows, and others containing brown trout. Very little surface water got into these ponds. They had a very abundant supply of spring water. Now after every severe storm whenever lightning would strike the ground within a short distance of those ponds, a large number of the brown trout and the rainbow trout would be killed. Some of them, after the storm was over, would be found dead, others struggling around in the pond very languidly, twisted and conformed and apparently something wrong with them. They would die within a few days. The loss in these ponds after each big storm, where lightning had struck the ground within a few hundred yards of them, was great, sometimes as many as 100 or 200 of those brown trout or rainbows would be found dead. The brook trout, however, rarely were killed. The indications were that they had not been shocked; and it was found always that it was either the brown or the rainbow trout, or the fish which touched the stone on the bottom of the pond, which were killed. So wherever the brown or brook trout were swimming free in the ponds they escaped, but wherever the stones were touched they were killed.

During the summer I received letters from all over the state about the death of fish in the streams, usually attributed to dynamiting. But

last year I received a letter and also specimens of fish from a stream in the northwestern part of Pennsylvania; and when we made an examination of them they bore the same earmarks that the brown trout and the rainbow trout did that were killed at the Allentown hatchery. I made an investigation and found that there had been a tremendous thunderstorm and that lightning had struck the trees and ground in several places along the shores of that stream—not the stream itself—but it struck on the shore and the fish, as I say, bore the same marks as those fish which were killed in the Allentown ponds.

PROFESSOR DYCHE: I have been fishing since I was a boy, and in four or five instances I have stood on the banks of streams fishing where lightning struck a tree right on the shore of the creek. In one instance a large elm was struck and a strip of bark and splinters was torn out from the top to the bottom of the tree which was actually split in places. I never knew of a fish coming to the surface on account of those heavy strokes of lightning along an ordinary stream. If it is possible to kill such fish as bass, catfish, buffalo, or carp, the lightning must be right close to them. I do not know about the trout.

MR. MEEHAN: The fish from northwestern Pennsylvania to which I referred were suckers and catfish almost entirely; although there were said to be two or three bass. They were fish that would be naturally on the bottom of the stream; and this stream is very rocky and stony.

DR. FIELD: I wish to say a word in appreciation of the work of Dr. Forbes and the Illinois Commission in this line. It seems to me that it is the best that has been done in this country. We in the United States do not at all appreciate the importance of this type of economic work. We hear a great deal about the increased cost of living and here we are on the one side throwing out the very material which is most needed on the land, and, more than that, by means of this same material we are destroying the fish in the streams. I have just come from the Conservation Congress at Kansas City where the dominant tone was the conservation of the soil; and yet almost from the very windows of the convention hall you could see men carting off the manure from the stock-yards and dumping it into the streams! It is a common practice to dump manure into streams instead of putting it on the land.

In the northeastern section of the United States conditions are complicated by the fact that the sewage is mingled with a very large amount of manufacturing waste, and is not in so dilute a condition as is that of Chicago; and though the conditions in the Illinois River are bad, they are infinitely worse in the manufacturing communities in the east. Yet our streams are capable of producing as many fish per acre, or as much fish food per litre of water, as are the streams of any section of the country. The Blackstone River in Massachusetts is notoriously the worst polluted river in the world.

Now our section of the country does not appreciate the importance of taking up the work, such as Dr. Forbes has done. He has shown

that under certain conditions the fish in these streams may be increased five, ten, twenty, or even a hundred fold or more, by careful attention to these matters. I believe thoroughly that this Society ought to go on record very strongly in some way in regard to this matter of pollution. It is, in my opinion, the one big question with which the fish interests are confronted, not alone on the streams but on the coasts where this polluting material goes into the salt water. Now unless it is nitrified and oxidized before getting to the bottom of the salt water, it remains there as a slimy ooze; accumulates practically never to disappear, because of the deficiency or even absence of oxygen.

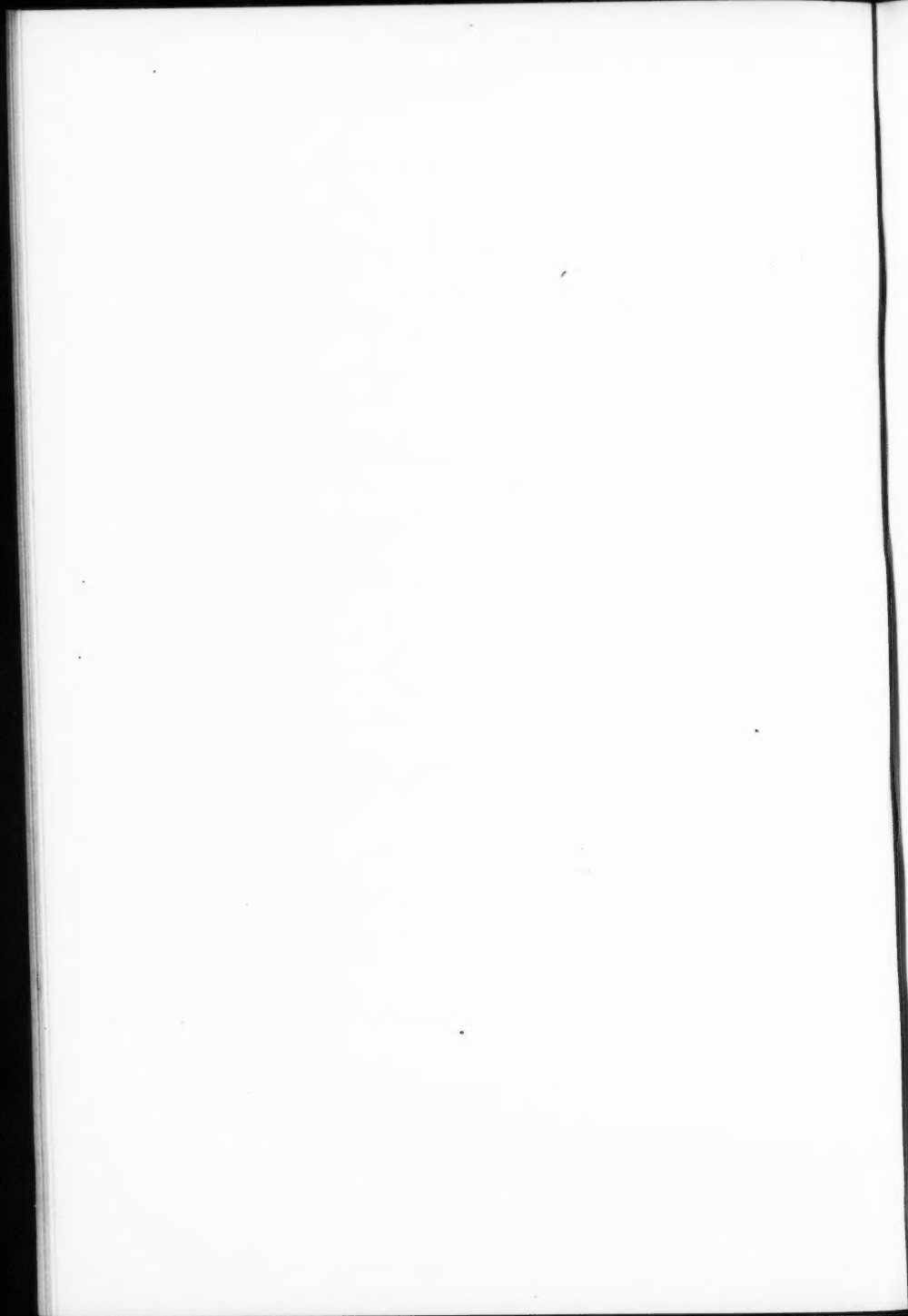
We have had that experience in Boston and New Bedford Harbor, and many other places. Our best illustration is perhaps Boston Harbor, where by the expenditure of about \$27,000,000 the sewage of a large district has been collected and discharged into tidal waters. We found upon examination that the shellfish production of Boston Harbor should be in terms of food value normally not less than \$400,000 a year; and \$400,000 a year will pay the interest on a pretty large sum of money. This source of food and wealth has been rendered not only worthless, but even made a positive menace to the public health, by becoming a source from which polluted clams are marketed. And this, too, in addition to the fact that this nitrogenous material, which is extremely valuable as a fertilizer, has been actually wasted.

When we note that Berlin and other European cities are conducting their sewage on to agricultural land and renting that land for a price up to \$35 an acre, it is time for the American people to open their eyes.

MR. MEEHAN: I suggest that you prepare a resolution on this line for submission to the Society. I think it should be done perhaps this afternoon and then it can be acted upon. I think this is a very important matter.

DR. FIELD: I will do so.

DR. S. P. BARTLETT, Quincy, Ill.: I want to go on record as being heartily in accord with the last speaker's remarks. Many of our most beautiful streams in Illinois today are simply sewers. Where great quantities of black bass used to be taken, we have nothing but cesspools. I should like to see the Society adopt a resolution on this subject, so that we can get a start with our legislators. I am heartily in accord with the sentiment.



LICENSES FOR HOOK AND LINE FISHING

By T. S. PALMER

Licenses for commercial fishing are so generally required as to excite little comment, but the requirement of licenses for angling or fishing with hook and line is comparatively recent, and at present in an experimental stage. By many persons the idea is not regarded with favor; some consider it an interference with their constitutional rights and others view it as an unnecessary and burdensome restriction. It should be remembered, however, that licenses for hunting game for sport as distinguished from market hunting licenses have been gradually adopted during the last 15 years until at present they are required of residents in 34 states and 6 Canadian provinces, and in the case of non-residents are required in all the states and all the Canadian provinces.

STATES REQUIRING HOOK AND LINE LICENSES

At present at least 11 states, chiefly in the northern Rocky Mountain and plains regions, have adopted some form of angling license. One of the first of these states was Nebraska which, in 1901 (chap. 36), required the same license for fishing as for hunting either by residents or non-residents. Idaho and Montana followed in 1905, but the Montana license proved unpopular and was repealed at the following session of the legislature only to be re-enacted in 1909. The 11 states which now have hook and line licenses, with the dates of adoption of the law, are as follows: Arkansas (1911), Colorado (1909), Idaho (1905), Minnesota (1911), Montana (1905), Nebraska (1901), Oregon (1909), South Dakota (1911), Utah (1907), Wisconsin (1909), and Wyoming (1911).

Licenses in Arkansas, Colorado, Minnesota, South Dakota, Wisconsin and Wyoming are required only of non-residents and those in Arkansas are local and limited to two or three counties.

FEES

The fee for the privilege of angling is nominal, usually \$1, but sometimes more in the case of non-residents—\$2 in Idaho and South Dakota, and \$5 in Oregon and in Clay County, Ark. The object of a fee is not to prohibit fishing, but merely to require those who enjoy the privilege to contribute something toward the maintenance of the work of fish propagation and protection. In Wisconsin the law provides that one-half the proceeds of hook and line licenses shall be credited to the fish commission, which has charge of the work of fish propagation, and one-half to the hunting license fund which is the fund from which expenses for warden service are paid.

How large a fund a fishing license will produce is uncertain for the reason that no state has yet required separate hunting and fishing licenses from both residents and non-residents. The receipts from the non-resident license in Wisconsin were \$8,606 in 1910 and \$8,560 in 1911. The adoption of the combination license for hunting and fishing in Idaho has greatly increased the number of licenses issued as will be seen by comparing the returns for the years 1903 to 1910. The first hunting license law was passed in 1903 and the first fishing license in 1905; in 1907 a separate non-resident fishing license was provided with a fee of \$1, and in 1909 the fee was increased to \$2. Statistics for the first two years show receipts for hunting only while those for other years show receipts for both hunting and fishing.

RECEIPTS FROM HUNTING AND FISHING LICENSES IN IDAHO

Year	Non-resident fishing	Non-resident hunting	Resident hunting and fishing	Total
1903 .....	....	\$1,735	\$12,370	\$14,105
1904 .....	....	....	13,000	13,000
1905	\$1,063	1,040	15,010	17,113
1906	1,606	625	18,074	20,305
1907	2,223	1,020	27,440	30,683
1908	2,219	710	31,831	34,760
1909	4,692	1,380	38,483	44,555
1910	6,180	1,565	44,606	52,351

COMBINATION LICENSES

Most fishing licenses are issued in combination with hunting licenses. The case can perhaps be more clearly stated by saying that in Colorado, Idaho (resident), Montana, Oregon, Nebraska, Utah, and Wyoming the hunting license carries with it the privilege of fishing. The effect of such legislation is interesting. Most hunters are also fishermen and offer no objection to the requirement of a fishing license inasmuch as it entails no additional expense. All fishermen, however, are not hunters, and some find it convenient to go fishing during their summer vacation before the hunting season opens. In the case of non-residents the licensee is apt to regard it as something of a hardship to be compelled to pay fees varying from \$5 to \$25 and intended primarily to cover hunting, when he cannot or does not care to avail himself of the privilege of hunting.

For statistical purposes the combination license is a distinct disadvantage, as it is impossible to separate the hunters from the fishermen, and although the fishermen usually greatly outnumber the hunters it is no longer possible to estimate even approximately how many persons have taken out licenses solely to hunt game.

MANNER OF ISSUE

The manner of issuing fishing licenses is usually the same as that of issuing hunting licenses. In Idaho and Wisconsin the work is performed by the warden; in Colorado and Nebraska by the commissioner or the county clerk; in Minnesota by the game commission, warden, or county auditor; in Montana and Utah by the warden or justice of the peace; in South Dakota by the warden or county treasurer; in Arkansas and Oregon by the county clerk; and in Wyoming by the justice of the peace. Details of issue in each state are shown in the following table:

DETAILS OF ISSUE OF FISHING LICENSES

State	Kind of license	Fee	By whom issued
Arkansas—			
Clay County.....	Non-resident	\$5.00	County clerk
St. Francis County.	Non-resident hunt- ing and fishing on own land...	10.00	do.
	Non-resident, own- ing no land....	25.00	do.
Colorado	Non-resident or alien, hunting and fishing.....	12.00	Commissioner or county clerk
Idaho	Non-resident or alien	2.00	Warden or deputy
	Resident fish and game	1.00	do.
Minnesota	Non-resident	1.00	Warden or auditor
Montana	Non-resident	1.00	Warden or justice
	Alien	5.00	Warden or deputy
	Resident citizens, hunting and fishing	1.00	Warden or justice
	Non-resident, gen- eral hunting and fishing	25.00	Warden
	Non-resident, lim- ited, hunting and fishing	10.00	do.
Nebraska	Resident, hunting and fishing.....	1.00	Commissioner or county clerk
	Non-resident hunt- ing and fishing.	10.00	do.
Oregon	Resident hunter's and angler's...	1.00	County clerk
	Non-resident, an- gler's	5.00	do.
South Dakota	Non-resident	2.00	Warden or coun- ty treasurer
Utah	Resident, hunting and fishing.....	1.25	Commissioner, warden or jus- tice of the peace
	Non-resident hunt- ing and fishing.	5.00	
	Alien do.	100.00	
Wisconsin	Non-resident	1.00	Warden or deputy
Wyoming	Non-resident or alien, general hunting and fishing	50.00	Justice of the peace
	Non-resident, lim- ited, do.	5.00	do.
	Alien, limited, do.	20.00	do.

LIMITATIONS UNDER FISHING LICENSES

Several of the states exempt women and children from fishing license requirements, although no distinction of sex is stated in the laws of Arkansas, Colorado, Minnesota, Montana, South Dakota, Utah, or Wyoming. The exemption of women in the Wisconsin law has caused frequent evasion of the statute and has sometimes rendered enforcement difficult even if it has not materially reduced the receipts. There seems to be no good reason why all adults who care to fish should not pay a license. The age limit varies considerably in the laws of several states. In Idaho exemptions are made in favor of boys under 12, in Oregon under 15, in Wisconsin under 16, and in Nebraska under 18. Exemptions are also made in the case of persons fishing on their own lands. Arkansas, Nebraska, Oregon and South Dakota grant land-owners the privilege of fishing or hunting on their own property without obtaining a license.

In the following table are shown the sex and age limitations in the various fishing licenses, and also the dates of adoption and the kind of license, *i. e.*, whether fishing or combination fishing and hunting.

CONDITIONS OF FISHING LICENSES

State	Kind of License	First Adopted	Sex	Age Limit	Fishing or Combination
Arkansas—					
Clay County.....	Non-resident	1911			Fishing
St. Francis County	Non-resident own- ing land.....	1911			Combination
	Non-resident own- ing no land....	1911			do.
Colorado	Non-resident or alien	1909			do.
Idaho	Resident	1905	Males	12	do.
	Non-resident or alien	1905	Males	12	do.
	Non-resident or alien	1907	Males	12	Fishing

CONDITIONS OF FISHING LICENSES—Continued

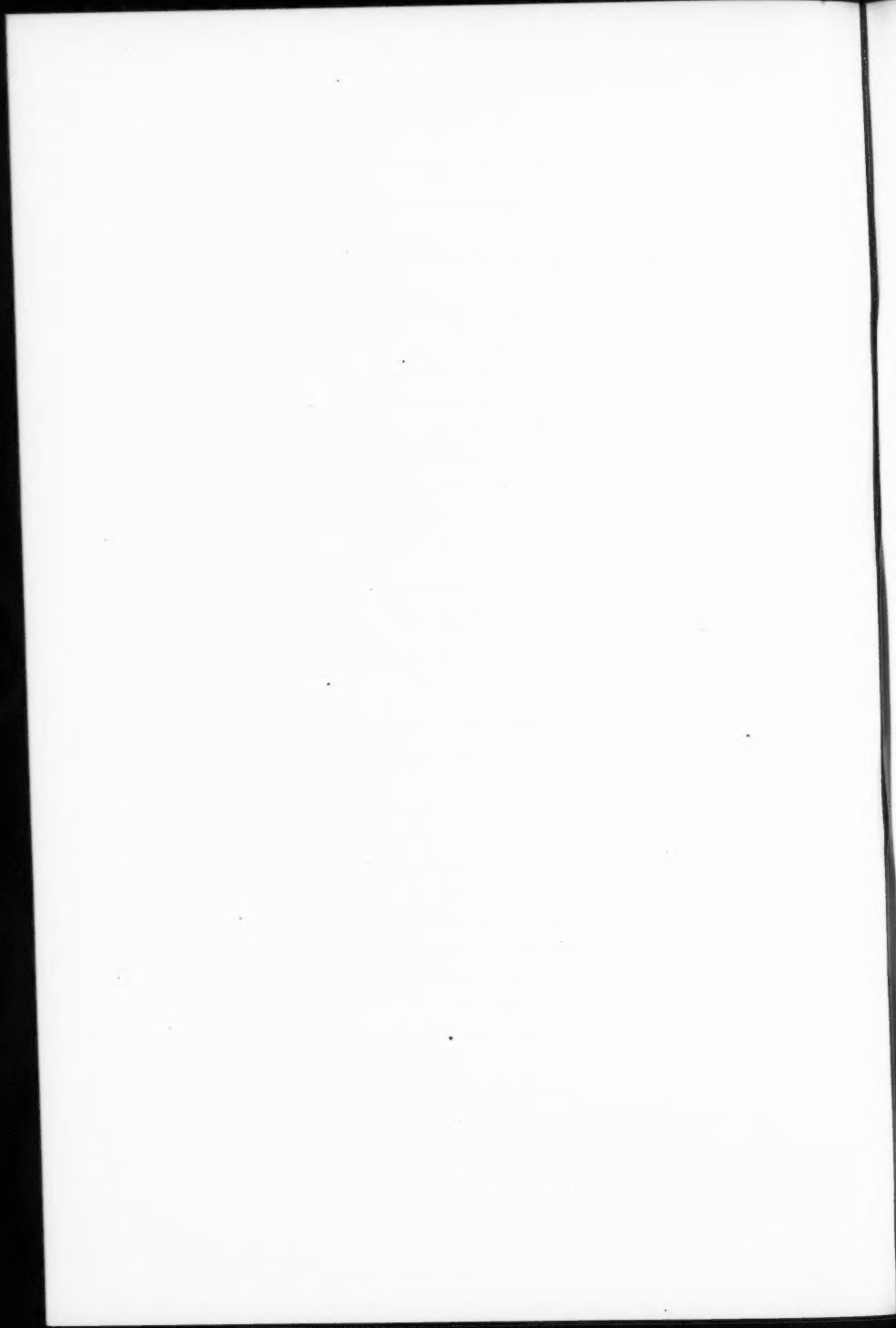
State	Kind of License	First Adopted	Sex	Age Limit	Fishing or Combination
Minnesota	Non-resident	1911		21	Fishing
Montana	Non-resident or alien	1905			do.
	Resident	1909			Combination
	Non-resident, general	1909			do.
	Non-resident, limited	1909			do.
Nebraska	Resident	1901	Males	18	do.
	Non-resident ...	1901	Males	18	do.
Oregon	Resident	1909	Males	15	Fishing
	Non-resident ...	1909	Males	15	do.
South Dakota	Non-resident ...	1911			do.
Utah	Resident	1907			Combination
	Non-resident ...	1907			do.
	Alien				do.
Wisconsin	Non-resident ...	1909	Males	16	Fishing
Wyoming	Non-resident or alien, general ..	1911			Combination
	Non-resident, limited	1911			do.
	Alien, limited....	1911			do.

PRESENT TENDENCIES

The present tendency seems to be distinctly in the direction of charging both residents and non-residents a reasonable fee for the privilege of fishing, and thus requiring those who enjoy the sport of angling to contribute toward the expense of keeping the streams stocked and patrolled. Heretofore in some cases this expense has been met in whole or in part by receipts from hunting licenses, but such a policy is distinctly unfair to the sportsman and has not met with favor. If the hunter is taxed for his sport it is no more than fair that the fisherman should contribute something for his pleasure, and it is manifestly unjust that the sportsman should be taxed for hunting and compelled to carry the burden of stocking streams for which the fisherman contributes nothing. It is perhaps to offset this objection that the combination licenses have been adopted.

Another equally important tendency seems to be in the direction of reasonable fees and in the reduction of the high

non-resident licenses which have been required in certain states. Statistics are not yet complete enough or available for a sufficient number of years to warrant any definite conclusions as to how much money may be raised by a hook and line license but it is reasonably certain that a \$1 license for residents and a \$2 or \$5 license for non-residents will produce ample funds to meet present needs. The simpler the licenses and the easier it is made for the public to obtain them, the more popular will the system become and the larger will be the funds for fish propagation and protection.



THE FUTURE OF OUR BROOK TROUT

By S. F. FULLERTON

I am not a pessimist by nature, in fact I would rather look on the bright side of things than on the dark side. Thus when I say that the brook trout, the lordly *Fontinalis* we all love, is doomed if we do not change our methods and get closer to nature than we have been doing, it must be plain that I am indeed apprehensive. We have been receding from the natural way of keeping our breeders and getting into what I will call the commercial way. Our aim has been to get all the eggs we possibly can from a given lot of breeders regardless of how many of the eggs hatch or the vitality of the fry after being hatched; in other words, we are in the business for the money there is in it. If we are hatching fish for the state it is the showing we can make—the millions we can report as sent to the streams from the different stations. It is not the number of good fish sent out, strong, healthy fish that, when the time comes, will reproduce their kind as their forebears did.

Now let us look at conditions at the average brook trout station. Ponds are prepared of size so as to be convenient when the spawning season arrives. Into these ponds our breeders are put and in nine out of ten cases an insufficient amount of water is furnished to insure good healthy trout. Then they are fed on mush or mush and liver, depending on how cheaply we wish to run the station. The quarters they are in are often entirely inadequate for the number held. The fish cannot get a proper amount of exercise, even if they have the proper food, and when the time comes for them to spawn they produce eggs that hatch puny fish and weak. The percentage of hatch is way below what it should be and those that do hatch hug the screen at the end of the trough, poor weaklings that they are. They have to be nursed and coddled as any other weak infants from weak parents, and

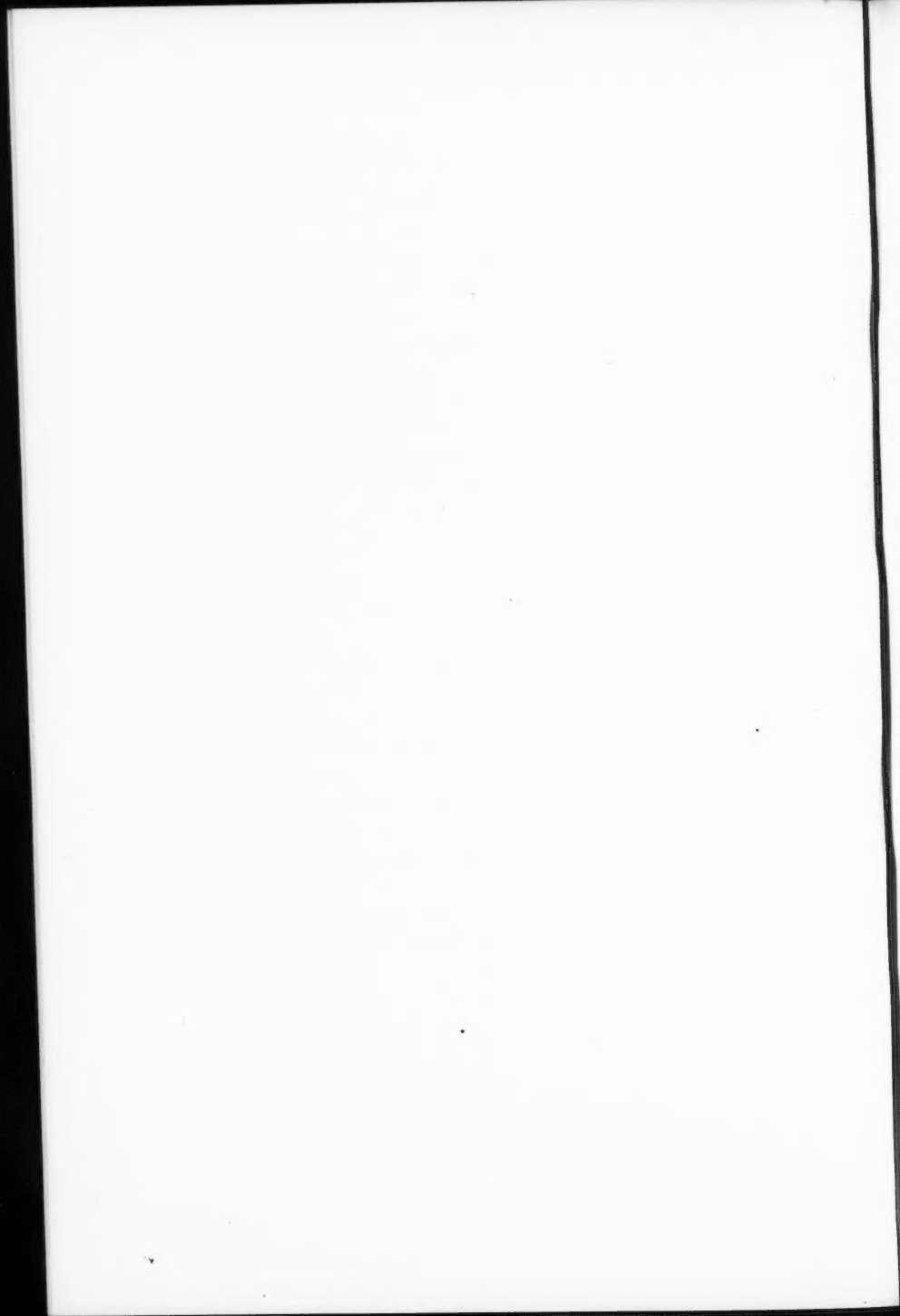
if they ever do grow up they have no life, no vitality, and no future.

You say this is a very dark picture. Members of the American Fisheries Society, the picture is true to life. There are exceptions of course, but they only go to prove the rule. Why I have seen eggs, not only one lot but several lots, come from these mush-fed breeders that were dear at 15 cents a thousand, and if we keep this up I can see nothing for the future. Of course there is a remedy and that remedy is right in our own hands. We have the power to stop this method or methods that I have been describing. Get back to nature and nature's ways; provide large roomy ponds with an abundance of pure cold water; introduce into these ponds natural food, the food that the trout like in their wild state; take no eggs from fish that are less than two and one-half years old; get the fry in your stream as soon as they destroy the yolk sac; and never let them taste liver unless it is absolutely necessary to carry them along; then when these fish grow up and the sportsman who perhaps has helped to plant them goes to the stream he finds fish, good, strong, healthy fish that jump for his lure like the trout of the old days.

I am not talking from some imaginary case. I have experimented with liver-fed or mush-fed fish and with fish treated as if they were in their wild state. As for the former I would just as soon catch so many suckers. But it is the future of our trout that I am looking out for. Take any other living thing, from man down, and treat it the way our brood trout are treated and how long would the race last? Only a few generations. You cannot disregard the laws of nature and expect nature to smile on you, for the closer we follow nature the better results we will have. This is true of every living thing.

Now I know that some of you will not agree fully with what I say in this paper, but I do want you, every one who raises brook trout either for the market or for stocking the streams of state or nation, to think this matter over; look

at your eggs, look at your fry, and compare the results of both methods of which I have spoken. The government, which is the largest purchaser of eggs from the commercial stations and which has done and is doing such splendid work in stocking our streams, ought to take up this matter, look into it, and see if there is not something to my warning. There should be a demand, before you buy any eggs, that the parent fish should be kept in ponds or a stream that is suitable, and that natural food has been furnished the fish. It will then be only a short time until we are back on the right road from which we wandered a few years ago. Then will the future of our trout be assured.



IS IRRIGATION DETRIMENTAL TO TROUT CULTURE?

BY W. T. THOMPSON

The question of the relation of irrigation to trout culture is necessarily one of comparatively recent date, though irrigation itself is as old as civilization. In the new world, it successfully encountered unique irrigational problems on the high plains of the great west, where the growth of irrigation in recent years has been phenomenal. Few realize even in a small measure how much it has done for this section of our country. Our "Great American Desert" is being rapidly irrigated out of existence. Where it once stood, we now find prosperous agricultural communities, supporting thriving towns and cities.

As public spirited citizens we cannot but take pride in these material evidences of progress. As fish culturists, however, and as members of this American Fisheries Society, should we not consider whether in this wholesale diversion of large quantities of water for irrigation, there exists no menace to the cause of fish culture; if such would appear to be the case, whether these unfavorable conditions are permanent and enduring or whether they are susceptible of modifications; and finally, whether in the evolution of the science of irrigation from its cruder forms to its more finished state there may not arise some new factor which will bring about a readjustment of conditions on a more favorable basis?

Our early irrigation, like that of the ancients, was largely basin irrigation, dependent on floods; available only for a limited time and covering but a restricted area. It was the creation of the more or less primitive conditions then existing. The pioneer settled in the valleys, where by a minimum amount of labor and expense he could irrigate a sufficient area of land to provide food for the family and a limited provender for the family cow and work horses. Other set-

tlers followed, additional small ditches were taken out; the larger co-operative canals followed. Soon all the natural flow during the summer season was appropriated. That thousands upon thousands of trout of all ages, but more especially those of the smaller sizes, were daily being carried into the ditches, only to die upon the fields, scarce occasioned comment.

Meanwhile the hunger for land and the thirst for water continued to grow, until the latter was largely over-appropriated even in favorable years, while in years of drouth many ditches were dry practically the entire season and the rivers themselves became dry beds further and further toward their mountain sources. The harvest of the land was swallowing up the harvest of the waters. Even then there came but a faint warning note from the more far-seeing of those whom we now term "conservationists."

Speaking broadly for the whole inter-mountain country, but more specifically for Colorado, this early irrigation, coupled with the pollution of the mountain streams by mining and lumbering, threatened the complete destruction of the native fishes, as well as fish culture, which was then in its infancy.

No less an authority than Dr. Jordan, after an exhaustive examination during the summer of 1889, summed up the situation as follows:

In the progress of settlement of Colorado, the streams have become more and more largely used for irrigation. Below the mouth of the cañons, dam after dam and ditch after ditch turn off the water. In summer the beds of even large rivers (as the Rio Grande) are left wholly dry, all the water being turned into these ditches. Much of this water is consumed by the arid land and its vegetation; the rest seeps back turbid and yellow into the bed of the river, to be again intercepted as soon as enough has accumulated to be worth taking. In some valleys, as in the San Luis, in the dry season there is scarcely a drop of water in the river bed that has not from one to ten times flowed over some field, while the beds of many considerable streams (Rio la Jara, Alamosa, etc.) are filled with dry clay and dust.

Great numbers of trout, in many cases thousands of them, pass into these irrigation ditches and are left to perish in the fields. The destruc-

tion of trout by this agency is far greater than that due to all others combined and it is going on in almost every irrigating ditch in Colorado.

He goes on further to state:

It is not easy to suggest a remedy for it. The valleys in question would be worthless for agriculture were it not for irrigation, and the economic value of the trout is but a trifle as compared with the value of the water privileges. It is apparently impossible to shut out the trout from the ditches by any system of screens. These screens soon become clogged by silt, dead leaves and sage brush, and thus will not admit the passage of the water.

Perhaps most of the trout are lost by entering the ditches in the fall, when running down stream with the cooling of the water. It has been suggested that a law could compel the closing of the ditches after the harvest, allowing the streams to flow freely until March or April.

In the fall the water is worth most to the fish and least to the farmers. I am unable to say whether this plan will prove practicable or effective. This is certain, that if the present conditions go on the trout in the lower courses of all the streams will be exterminated and there will be trout only in the mountain lakes and mountain meadows, to which agriculture cannot extend.

More than two decades have now passed. Yet in spite of the admittedly unfavorable conditions, which fully justified Dr. Jordan's gloomy predictions, we find that this irrigated section, and especially the more accessible and better advertised Colorado, is today the angler's paradise. Not only is the native trout still found in abundance, but brook and rainbow trout as well. In fact Colorado and Wyoming's reputations are upheld largely by the magnificent rainbows found in the larger streams. Brook trout have become so plentiful and widely distributed that many people are inclined to think them indigenous.

In the swift, clear, cold waters of the Continental Divide, both the rainbow and brook trout attain a degree of excellence rarely found in their native habitat, even under the most favorable conditions. The fish grow larger, are more vigorous and gamy, while the eggs are more hardy and virile.

That these are not the mere claims of an enthusiast, but are proven facts, is best attested by the heavy demand made

on this region by the Bureau of Fisheries for spawn for brood stock at hatcheries all over the country. Indeed, shipments of spawn from these introduced varieties are being made every year, and with splendid success, to foreign countries, as France, Germany, China, Japan and Argentina.

Commissioner Bowers in his report for 1905 states:

The value of the Bureau's efforts to increase the supply of food and game fishes in the interior waters have been strikingly illustrated in Colorado where a number of non-indigenous trouts have been thoroughly established. The principal fish thus introduced is the eastern brook trout, which is widely distributed in the state and probably exists there in greater abundance than in any other state. Colorado has now become the Bureau's chief source of supply for the eggs of this species, and nowhere else is it possible to collect such large quantities of eggs from wild trout.

You ask me how we can harmonize or explain these existing favorable conditions of trout culture with the unpromising outlook of 1889? In our analysis of this question of the relation of fish culture, or to remain more clearly within the limits of our subject, trout culture, to irrigation, we find two stages of development and growth. The first or basin period had reached its zenith at the period of Dr. Jordan's investigation, while the second or perennial stage was but in its infancy; hence was not recognized as being a possible factor in the future readjustment of fish-cultural problems.

It had early been realized that only a small proportion of the suitable lands could be irrigated from the natural flow from the streams during the summer months. Storage of the flood waters was recognized as the only possible solution of the problem of the utilization of these otherwise valueless acres. Investigation disclosed the fact that away up among the mountains there existed many ideal sites where reservoirs could be constructed at small cost and filled from the melting snow, and where this surplus water could be stored until needed.

Reservoirs of varying sizes were created as though in a night. First came those built by the individual and by

local co-operation; then came the larger enterprises financed by outside capital; finally we have the immense enterprises encouraged by state and nation.

Many of these earlier and smaller lakes, as they are frequently called, were promptly stocked with trout. The results already attained have been absolutely incredible and beyond the belief of those who have had no personal experience under similar conditions. I do not propose to weary you by going into detail, but still I cannot refrain from giving you several striking instances which may enable you to realize to some extent the fish-cultural possibilities of these lakes.

Wellington Lake, located on the Colorado & Southern Railway, about twelve miles from Buffalo, Colo., yielded 4,358,000 brook trout eggs during the fall of 1904, while Island Lake, the summer of the same year, produced over 8,000,000 spawn of the native trout.

Perhaps the most striking illustration, however, is in the case of Ragan Lake, located some twenty-five miles from Creede. This is a rather shallow body of water containing approximately seventy acres and is operated by Mr. B. C. Hosselkus as a commercial enterprise. During the latter part of February, 1906, Mr. Hosselkus received from the Leadville station of the U. S. Bureau of Fisheries 100,000 eyed brook trout eggs in exchange for rainbow spawn. These were shipped to Creede over the Rio Grande and arrived in the midst of a severe blizzard. When the storm had ceased, the trays were transferred from the heavier shipping cases to light wooden boxes, such as are used by the oil companies for the shipment of two square five gallon cans. They were then placed on a pack horse and started up the mountain over the unbroken trail.

On several occasions the pack animal lost her footing and fell, rolling down the mountain, but the heavy soft snow prevented any material injury to horse or trout spawn. To prevent freezing, one night the eggs were wrapped in blankets and kept in a ranchman's cellar; the next night

they were carefully covered and set by the kitchen fire. The third day they reached their destination and were placed in Mr. Hosselkus' hatchery, where they commenced to hatch almost immediately. The resulting fry were held in troughs and fed until the first of May, when they were planted in the lake as no. 1 fingerlings.

With the cold mountain water at Leadville we rarely hatched our brook trout in less than six months. This was advisable because the mountain streams were not ready to receive fish until June or July.

Early in October, 1907, seventeen months later, on Mr. Hosselkus' invitation, I visited the lake. The trout were just commencing to come into the shallow water. The first evening I tried to amuse myself with fly fishing. The catch at each cast was limited only by the number of hooks. Releasing two and three fish after each cast soon grew monotonous, and I gave it up, voting it butchery rather than sport.

Mr. Hosselkus had meanwhile set two small gill-nets in deep water with a view of catching some large rainbows, the remnant of a small plant made several years earlier. None being taken then or thereafter, he concluded they had either been caught or had died during the previous winter. The nets, however, were literally full the next morning of ten-inch brook trout, which averaged one-half pound dressed. The females were full of spawn, almost ready for extrusion. The latter part of the month and the first half of November, Mr. Hosselkus filled his own hatchery, shipped large quantities to the Denver hatchery of the Colorado Commission, besides sending upwards of three millions to the Leadville hatchery to be eyed on shares. Owing to insufficient help and inadequate facilities the full amount of spawn available could not be taken, though the harvest exceeded ten millions! Is it not truly incredible?

The factor then which has prevented the threatened annihilation of the trout in the inter-mountain country, has been the multiplication of these mountain reservoirs, and not alone through the number of fish actually propa-

gated in them, but more through the large supplies of spawn obtained from them to fill private, state and national hatcheries, later to enter into the general distribution. In addition, I might mention that the filling of these reservoirs during the spring months tends to lessen the flood conditions at that time, while the turning into the streams during the summer months of this stored water preserves a more equal stage during the angling season. The fishing is further improved by the escape from the reservoirs of a large number of matured trout which pass out through the headgates with the water.

Summing up the situation and applying this analysis to the query propounded: We find that irrigation in the earlier stages and under primitive methods is decidedly detrimental to trout culture, though some of the more injurious features are susceptible of improvement. In the more advanced or perennial stage, with the numerous large and small reservoirs storing the flood waters and releasing them as required, we are glad to be able to reverse the verdict and find that irrigation is not detrimental to trout culture. In fact when these reservoirs are utilized as great fish-cultural preserves, then irrigation becomes a most important factor in the upbuilding of fish culture and the improvement of angling in the inter-mountain country.

Irrigation and fish culture have long been considered as being antagonistic; the growth of the one was supposed to mean the decline of the other. My personal observation disproves this, hence I am only too glad to sound an optimistic note and declare to you that these interests are harmonious though not always identical. The present marvellous development of irrigational projects in the west therefore becomes an occasion for sincere congratulation from fish culturist and angler, as well as to our more prosaic brethren who till the soil, since it carries with it wonderful possibilities for fish-cultural expansion.

In recent years, we have heard much of "conservation" and "reclamation." Great as are these themes and fraught

with magnificent possibilities for the betterment of humanity, they are incomplete of themselves and fall far short of yielding the greatest possible returns, until the cause of "fish culture" is inseparably associated with them. Conservation has had her Pinchot, reclamation her Carey. Who will rise up and champion the cause of irrigational fish culture?

DISCUSSION

MR. THOMPSON: This is to some extent a new subject, particularly so to many of the members of the Society now before me who have never had the opportunity and privilege of working in the irrigation regions, and who, therefore, are not as familiar with the matter as I would like. Hence a full and free discussion, which I urgently solicit, will be especially helpful to us all.

PROF. L. L. DYCHE, Pratt, Kan.: I understood the gentleman to say that it was not possible to regulate the outgoing of fish into these irrigation ditches by the use of wire screen nets. Is that right?

MR. W. T. THOMPSON, Fairport, Iowa: That was Dr. Jordan's statement, and I endorse it as correct.

PROFESSOR DYCHE: I do not know just what your conditions are, but I do not have any difficulty in managing fish with wire screens. All the ponds in the new fish hatchery for Kansas will be connected by water-ways that are two feet nine inches wide, and we expect to manage the fish, keeping them out or letting them go into certain places, by wire screens. These screens are made in sections, some 500 of them in all. Those with 3-inch mesh wire are used to keep out coarse stuff, as weeds, brush, moss and wood. Other screens are used as conditions may demand and are made of one-inch, one-half-inch or one-quarter-inch mesh wire. One or more of the screens may be used at the same time. If small fish are to be controlled the mesh may be as small as that used in window screens. We have experimented some, and have had no trouble in keeping out trash, weeds and grass by regulating it with different sized screens. One of the men who has charge of the hatchery grounds goes around, lifts screens and takes out trash; and we do not understand why you cannot keep trash out of irrigating ditches if you will build a cement structure in which the screens of different sized mesh can be fitted, and thus control both trash and fish in the ditches. I do not see why both fish and trash cannot be managed if you put in proper screens. Such a system may need a little care, but it seems to me that it can be successfully operated.

MR. THOMPSON: Where was it you were making these experiments?

PROFESSOR DYCHE: In Kansas. I have a paper bearing on the subject and I will present the matter later in my paper, with accompanying blueprints.

MR. THOMPSON: What is the size of your pipe?

PROFESSOR DYCHE: It is 21-inch pipe carrying $3\frac{1}{2}$ million gallons of water per day.

MR. THOMPSON: People have a wrong conception of what irrigating ditches mean. They are of all sizes, but the main canals are really small rivers.

PROFESSOR DYCHE: We have a river big enough to run a flouring mill which we expect to control through the use of wire screens.

MR. THOMPSON: Then again the irrigationist is not necessarily interested in the fish-cultural problem, and you have not only sage brush and silt, but sometimes young trees floating down the streams, which would soon clog the screens since there is no provision made for keeping them clean. Of course this is one of the problems we must solve. A revolving paddle wheel is one of the devices now being tested, but it does not absolutely keep all the fish from entering the ditches. It revolves through the force of the current, causing more or less disturbance of the water, the idea being that it frightens most of the fish back. As a matter of fact, while some of them escape into the ditches and are eventually lost, a majority are preserved. This device permits the passage of debris of almost any reasonable size. Most of this irrigation water comes tumbling down from away up in the mountains, carrying all sorts of debris; it would fill up any ordinary screen so quickly you would scarcely know what happened. The ditch riders and the water superintendents have a very large area to cover and frequently are not particularly interested in fish culture, hence do not want to be hampered by any system of screens. Thus far no system of screens has been a success and we are not disposed to blame them for their indifference. The water-user does not care to incur any extra expense. Here, then, is a problem which should properly be taken up by fish culturists and angling associations co-operating with the Water Commissioners and other proper state officials. Fish culturists have long endeavored to bring about a sentiment in favor of providing some device.

Several years ago while in Colorado I took up this matter of a campaign of education. The state of Colorado in the blank applications for fish inquired whether the headgates of all the ditches were provided with screens or other devices for preventing the escape of the fish. That was educational, because they could not well refuse to give people fish even if the ditches leading from the streams were not so protected. I suggested to the Washington office that the Bureau of Fisheries take cognizance of the irrigation work, and also insert in its blank applications this same, or a similar, inquiry. This was subsequently done. We hope to work up a sentiment which will eventually bring about some system of screens or paddle wheels that is both practical and effective. As yet, however, such a system has not been perfected.

PROFESSOR DYCHE: You answered the question when you first started out by saying they had no interest in the business and did not

care much about it. Of course if you have a big stream with logs running down, provision would have to be made accordingly; but moss, sage brush and sticks I think could be handled with ordinary screens.

MR. THOMPSON: It is a problem which has been up before a number of our states in the Rocky Mountain country and in California, especially. Simple as it may seem in theory, in practice it has been found most perplexing.

DR. H. B. WARD, Urbana, Ill.: Mr. President, I listened to the reading of the paper with a great deal of interest, because I have just returned from a 3 weeks' fishing trip in the San Luis valley, of which something was said, and while there I had the good fortune to come in contact with the places to which reference was made, and also with a number of persons in various walks of life representing different interests, so that I had some opportunity to get the point of view of different classes of persons on this question.

I am very glad to know from so careful a source that the changes in methods of irrigation have been advantageous to the propagation of our mountain trout. On the other hand, I cannot fully agree with the speaker that the situation is quite what it ought to be; and it seems to me that he gives away the secret of the whole matter in saying that those who are conducting the operations in connection with irrigation, do not want to bother with this problem. I think we have passed the time when any class of people has the right to say that it does not want to bother with a problem concerning the conservation of our natural resources; and I submit to this body, when from the irrigating ditches of the San Luis valley, trout, small trout, fair sized trout, to the extent, not of bushes or barrels, but to the extent of wagonloads, are shoveled out from those ditches in the fall, that the state of Colorado is not doing its duty at some point or other. It may be difficult to place the responsibility, though some persons might try to do it. It may be difficult to find the precise remedy, but a loss of that magnitude, the destruction of valuable fish represented by any such quantity, indicates a failure to safeguard the interests of that community, for which somebody or some class of persons is responsible; and I feel very strongly that we should not be doing our full duty if we failed to call attention to the problem very forcibly.

In talking with the citizens of that valley, I remember very distinctly the remarks that were made by some persons there which confirmed the statements of the author of this paper. One gentleman, a physician of education and standing, said to me that there was a device which was reasonably successful in keeping trout out of the ditches, referring to the paddle wheel device which has been mentioned; but that the people who owned and controlled the ditches did not want to bother with it, and that thus far the state had not compelled them to do anything.

Now, the state of Colorado is putting a great deal of money into hatching brook and other trout. Why, may I ask, are these fish per-

mitted to run out into irrigating ditches to be shoveled into wagons and used for fertilizer on the fields? It does not look like a good business proposition and does not look like what I should call modern methods for the conservation of these resources of the state.

I do not doubt that the parties in charge of irrigation projects will not spend any more money than they have to. I do not doubt that they will not find appliances, which are somewhat expensive, successful, until they are forced to put them in; and you could find parallel cases in other parts of the United States and in other lines of fish work, to say nothing of other types of work of an entirely different character.

It may be that the present method of irrigation and the establishment of great basins for the storage of water gives place for the hatching and development of a large number of fish that would not have existed under former conditions; but after all the real question comes back to us, whether through irrigation an unnecessary number of valuable fish are not lost to the community, and I am frank to confess, after having seen this region and having heard at first hand regarding the losses, that I cannot doubt that they reach a large figure, and that some way or other means ought to be taken to protect the state against that loss.

MR. THOMPSON: I am very glad that Dr. Ward happened to be here and had his finger on the pulse of Colorado with respect to the fish-cultural problem. Everything he has said meets with my hearty approval. I do not mean to be understood as saying that all the conditions in Colorado are what they should be; but I do claim that under existing conditions there has been a very marked improvement in the number of trout and in the quality of the angling in Colorado, considering the large increase in the number of anglers. Such being the fact; when public sentiment is properly educated, when the state authorities wake up to their responsibilities and prevent this wanton waste and slaughter of millions and millions of trout, Colorado will come into her own, and not only Colorado, but her sister states as well. I speak of Colorado, because the conditions there are better known, there is more irrigation, there is more fish culture and angling. When these great reservoirs, including the large state and national projects, are completed and properly utilized in a fish cultural way, and when, in addition, suitable protection is afforded our fish, which at present is not the case, then will Colorado and the whole Continental Divide country become in truth the playground of America.

I received a number of letters, shortly before I came here, from the passenger agents of the various railroads in Colorado, which I was anxious to include in my paper, but condensing as much as I could, I found their inclusion impracticable. Each one states that the angling industry is one of the big assets of their respective roads, and that it is increasing in value year by year. I know through personal experience that they are anxious to do all they can to assist in the work of propagation and protection. No one knows better than the passenger

agent just what this travel means, nor is any one more apt to be moved by mercenary motives. Hence when I state that the railroads are furnishing the state and national commissions with every facility needed for their work of propagation and distribution it is not only a tribute to the work of the state and national commissions, but a practical recognition of angling as an unquestioned source of revenue as well. The railroads in Colorado furnish the government with probably from 10 to 15 special cars a year for the transportation of government fish, besides furnishing transportation for messengers in the baggage cars. I think you may safely say their contribution to the cause of fish culture is almost equal to that of the state and the nation for the work in Colorado. This would not be the case excepting it had been proved that it yields them immense returns.

Now I brought this matter up largely that the Society might understand the conditions, and possibly voice a note of warning to the states and to the United States.

I visited one of the United States reclamation projects out in Nevada several years ago; it was on the Truckee River, one of the finest fishing streams in the country. I found that, in connection with the Carson-Truckee project, the river had been dammed, and with absolutely no provision in the original construction for the passage of fish. The investigations made at the time were brought about by telegraphic requests of the Nevada Fish and Game Protective Association to their senators, asking that the Bureau investigate conditions. They claimed that there were thousands of pounds of trout being taken daily out of the Truckee River just below the dam. Owing to the execrable fish laws of the state of Nevada, the pot fishermen were allowed to fish right in the midst of the spawning season, and were taking out 10,000 or 12,000 pounds of trout a week.

I investigated and found that one party of four on the first day the season was open had taken from a small fishing area just below this Truckee-Carson dam 1,060 pounds of fish! I verified this statement by going to the market man to whom they were shipped. This is a specimen of the abuses of irrigation. I wish to state that the government promptly provided a fishway in this dam at Derby, Nev. It is my understanding that in the later irrigation projects they have also provided fishways.

FRESH-WATER ANGLING GROUNDS FOR THE STRIPED BASS

By S. G. WORTH

In the lines following I set forth certain known fresh water localities where striped bass take the hook and sufficiently describe the character of such river areas as to point to similar grounds in intermediate streams where sport of the kind may have not yet become known. In order to give a practical value to the data I present the names of individuals as well as those of towns, and also the railroad crossings and routes, but without purposing in anywise the advertising of such individuals as guides or any of their wares. If my contribution is to serve a really useful purpose it must contain enough of such detail as to permit the seeker to correspond with or otherwise get in contact with parties on the scene, as those mentioned, the postmasters or railroad agents of the locality in view. As a matter of fact I do not know that even one of the persons named can be reached by letter or continues to reside in the same place. It is hoped that by pursuing this course a means will be afforded to others interested in gaining access to grounds through their own efforts, and at the right time of year and when water conditions are favorable.

The striped bass follows the run of herrings up the fresh water rivers, and spawns in water temperature 60° to 76° F., but mostly between 65° and 73°, and apparently the taking of the hook is to be expected only after their eggs have been deposited.

The numbers of striped bass vary greatly in different streams and their abundance or comparative scarcity is a factor, of course, in net or other kind of fishing. In the last 15 years the statistical tables of the Bureau of Fisheries and the Census Bureau throw much valuable light on the distribution of the commercial catch.

KNOWN GROUNDS

South River, North Carolina.—As early as 1875 I became aware of the capture of at least one fine striped bass—12 to 14 pounds—in South River near Hawes' Bluff, a point not on the map but on the Bladen and Pender County lines about due east of Kelly, a Cape Fear River landing in the former county. A local fisherman took the fish on a third day's trial and somewhat unexpectedly, as on the first two days his bait and hooks had been taken off with suddenness and so devoid of spring in the fishing line as to practically convince him that he had fouled the tackle on a sunken log. When he dropped his hook at the same spot in the same deep cove—a point he passed in going to and from the chosen black bass and crappie grounds—it was more an act of curiosity than expectation. To his amazement the hook was seized by a striped bass of such strength and size as to put him to his best effort to draw it into his skiff, and in the fish's jaws he found both his recently lost hooks and other hooks whose original owner could not be guessed.

This capture took place at a point 40 to 50 miles above the confluence of South River (there called Black River) with the Cape Fear, a stretch of down-flowing stream that is unaffected by the lunar tides more or less prevailing in the last named river up to the point of confluence.

Neuse River.—In 1877, having business at New Bern, N. C., I learned that hook and line capture of striped bass, a mile or two below the town and the confluence of the Neuse and Trent Rivers, was not uncommon but there were secrets or difficulties attending it that prevented general participation. One of the difficulties was the current belief that no bait was successful except fresh herring roe, an article denied except in the spring months and difficult to keep on the hook when had. It was understood that fishing on those grounds was by hand line. This point was not many miles above brackish water and in some years when the fall months were dry brackish water invaded the grounds where the

striped bass were fished for. Now that the Inland Waterway has been opened up from Beaufort or Old Topsail Inlet to the Neuse River, it is learned that the sea water is denser and advances yet higher up the Neuse River.

Roanoke River.—In the years 1879, 1883, 1884, and 1903 to 1909 inclusive, at Weldon, situated at the foot of the great rapids of Roanoke River—the most notable striped bass stream in North Carolina—I found scarcely an exception to the accepted belief that the striped bass would not bite a hook in that vicinity. The reason may be that this is a spawning ground, probably the foremost known spawning ground of the species. In the summer of 1904, however, I learned that fish were being caught on trot lines at a point some miles below and in surprising quantity. On June 7 of that year, my son, Henry B. Worth, in charge of a power boat which I was sending down the river to go into repairs at the Elizabeth City marine railway, stopped in somewhere about the Hobgood Post Office landing to take on water, this landing being not far from the Atlantic Coast Line Railroad crossing on the Rocky Mount and Norfolk branch. There he met a Mr. J. D. Savage who was then fishing with trot lines and by whom he was informed that at a point $1\frac{1}{2}$ miles above Hamilton two men in ordinary seasons would take about 200 pounds a day or approximately 1,000 pounds a week, employing fresh herring (alewife) bait. The last named town is perhaps 25 miles below Hobgood. Evidently the use of the hook was not entirely new in that region. It is also evident that a large angling resource awaits up-to-date single hook methods, the latter apparently not yet known there.

In 1905 a report reached me at Weldon through lawyers or others recently attending court down about the town of Scotland Neck that some hundreds of pounds of striped bass were being caught daily at some point near the last named town on trot lines, and closely following that report was another to the effect that similar captures were being made at the old, historic town of Halifax, situated but 8

miles below Weldon. Immediately, May 20, I proceeded to Halifax and found the report as to that town true. I met the parties who owned the outfits and made the catches and talked with each one and also other residents.

Mr. George H. Stevenson informed me that during 7 days, April 28 to May 5, just prior to a freshet, five skiffs that were operated with skim nets, locally designated "drag nets," for the capture of striped bass had incidentally taken 100 to 200 herring (alewives) per day, the heads of which were used as bait on three trot lines owned by himself, George S. Robinson and John Boyd, the colored public ferryman. The lines contained 50 to 250 hooks each and were stretched across the river, which has a width of perhaps 400 to 500 feet at Halifax, the hooks being 3 to 4 feet apart. With no other bait than the fish heads more than 600 pounds of striped bass were caught, sometimes 20 per day of sizes varying from 8 to 16 pounds, or double the amount taken in the drift nets. The river water was on the clear order but not to say transparent. The hooks were arranged as near as possible within six inches of the river bottom in a depth of from 15 to 25 feet. When the water became muddy the nets would catch more and the lines less. Not a hook was touched when the water became muddy. Though it was the spawning season no ripe fish were taken.

It was found that iced herring (shipped in) was of no value as bait and that the local catch of herring was unavailable as bait except when fresh. The herring captured locally commanded too high a price to warrant the experiment of employing the whole fish, which was bringing 10c. a pound after the heads were removed.

John Boyd had on April 26 caught 3 herring in a skim net, and with the heads he had caught on his 50-hook trot line 6 striped bass of sizes mentioned above. On April 24 he caught on the same line 16 additional ones that weighed from 6 to 12 pounds each.

Mr. Robinson had for many years operated fyke nets in this vicinity and now owned and fished as many as 47. He

said that at Halifax the fish would continue to bite till the end of May, water conditions being right. This was the second year of trot line trials at this high-up river point. He had known two men at Hill's Ferry, 20 to 30 miles down stream, to take on trot lines in one night the preceding season 2 large sacks of striped bass or as many as 5 bushels, and he had also known 1,005 pounds taken in 2 nights and 1 day at the same place by 2 men in 1903. Another citizen, a Mr. Hale, informed me that he had known 300 to 400 pounds to be taken on lines at Plymouth in a single day.

From the foregoing it appears that the Roanoke angling possibilities are great when the area of the stream is considered, the distance from Halifax to Plymouth being approximately 125 miles, while the distance between Hobgood and the river mouth at Albemarle Sound is in itself many miles. From the information gained I infer that the best part of the river, when length of season is considered, is from Hobgood to Plymouth or perhaps to the very mouth of the river.

It may be remarked that but for the immense stretch of nets in the water below, operated for shad, herring and striped bass, the Roanoke River would attain renown in striped bass production. That but a fractional part of the run enters that river compared with the number that would naturally ascend; I have all proof that I desire. Anyone who will take the pains to ascertain the times that were so phenomenal in rockfish or striped bass capture at Weldon and vicinity, when hundreds of visitors poured in from surrounding counties to fish and make purchases of fish and join in the great festal event of the year, with their teams of all descriptions and camping outfits, will discover that it was not an event of a hundred or two hundred years ago, but of the closing years of the war and just after, 1864-1867, when the nets and seines in the wide waters below were out of commission as a result of the presence of Federal gunboats which then cut off the fishing and left it crippled for a time after peace was restored.

Before passing on to another stream it should be stated that the striped bass of monster size avoid the trot line devices. At Halifax, for example, as many as 6 fish of average weight of 50 pounds were taken by the netters in just one morning in the year 1903, suggesting what great numbers escape the trot line fishermen and ascend the stream.

Susquehanna River.—It is on the Susquehanna River that enlightenment is afforded regarding the capture of striped bass on hook and line in waters above tide. Those grounds are but a few miles from the broad waters of Chesapeake Bay, but the water is perfectly fresh. The whole stream above Port Deposit, Md., may be considered as rapids, but at Octoraro Junction, as elsewhere all the way along for many miles, there are many pools in which the flow is quite slow at clear river stages or in the absence of freshets. Evidently these rapids are a natural spawning ground of the striped bass and both the shad and herring (alewives) ascend them, both species being caught by Mr. F. W. Irwin, of Octoraro Junction (P. O. Rowlandville), Md., and other seiners.

I visited this locality in August, 1904, and again in June, 1905, was there and spent several weeks with the angling activities under observation. Twenty New York and other clubmen would be there at a time engaged in angling, paying \$2.00 a day for board and \$3.00 for a boat and guide, besides \$1.50 per hundred for bloodworms which were used on the hooks of the spoon troll.

The season opened June 1 and continued some months, to be interrupted only by periods of too clear or too muddy water. Octoraro Junction is a Pennsylvania Railroad station and telegraph office and the anglers were usually told by wire when the conditions were favorable. Some of the anglers were prodigal in the use of the bloodworms, impaling all the hooks would hold. It is understood that while the bloodworm bait was everything that could be desired as an adjunct to the troll, the biting ceased immediately when the common red or angleworm was substituted. These worms

were obtained from A. H. Dirkes, 50th Street and 9th Avenue, New York, and arrived by mail or express. The worms are said to be the larvæ of a species of *Chirosomus*, *C. plumosus*. They resemble the common angleworm in shape, color and size.

I was interested to see that the bloodworms buried their heads and also perhaps 25 per-cent of the fore end of the body within themselves, in the manner of hosiery turned in and in most handy shape to put on. It was not a turning inside out but, rather, an introverting of the head and fore part of body into the middle body cavity. When received and not at once taken into the fishing skiffs or when kept over night the worms were put in a cavity a foot perhaps below the ground surface and protected with a covering of lumber and earth for preserving darkness, even temperature and moisture. These worms were all reputed to come from New Jersey salt water marshes.

All the anglers—one to a boat—payed out about 70 feet of line and fished over the stern, both angler and oarsman guide facing astern. The catches were fine, early morning and late evening hours, and although none of the mammoth fish were among the number the take of single skiffs not infrequently ran 100 to 200 pounds in one day. The catches were especially good and quickly accomplished when some large tree found lodgment in a pool of right depth.

Other probable grounds.—In all striped bass streams under my observation the species ascends in the spring months close behind the big run of herring (late April) and always to such points in the stream as present a stony bottom. Even in so diminutive a stream as Little River, South Carolina, the dividing line of the two Carolinas on the sea coast, and where the body of fresh water is only about a mile long, the species finds the hard bottom of coquina or phosphate rock. And I may here remark that it was while on this stream I heard a native say that the species invaria-

bly seeks such bottoms for the deposition of eggs and from this habit took its southern name "rockfish."

White Oak River.—While at Swansboro, Onslow County, in 1904, I learned enough of the size and numbers of the striped bass run in White Oak River, North Carolina, to suggest hook fishing in its waters. It empties into Bogue Sound at this point and is of stony bottom up toward the Atlantic Coast Line Railroad crossing near Maysville. I believe that it is open for skiffs from the crossing to the salt-water sound. The mouth of this stream can be reached with comparative ease from Beaufort or Morehead in sail or power boat of 30 inches draught, the distance being approximately 25 miles.

Alligator River.—From large intermittent net captures of fish of noteworthy size in somewhat recent years it appears that Alligator River is another North Carolina stream in which the species under consideration may be found of interest to the angler, a wild, wide-water region with densely wooded and tangled shores most easily reached in chartered boat by way of Elizabeth City. The most satisfactory means I found of getting around in those wide-water sounds was to employ an oyster schooner of 10 to 30 tons and put mattresses in the hold down flat on the sheathing, and where there was ample room to spread out clothing and other articles. It was necessary, however, to take someone along to do cooking, as the captain preferred his own mess to himself, in order to watch and otherwise care for his craft.

About muddy water.—There are no fixed terms for expressing the degree of muddiness of water that will give anything like a correct comprehension, in my knowledge, except those employed in the District of Columbia. On examining the local columns of Washington newspapers it will be seen that a daily report from the Great Falls is made of the temperature and condition of the Potomac River and the *condition* is always given in numerals, as 1, or 4 or 10, etc., these numerals indicating, as I understand, such number of inches as an object may be discerned in the water through

the side of a clean glass vessel with a straight side. I was informed in fact that the data were obtained and published largely, or perhaps solely for the benefit of anglers—to let them plan fishing trips to the best advantage with reference to catch and the saving of time.

River accommodations.—It should be said that on all the streams mentioned except the one in Maryland it would be necessary to provide a tent and commissary outfit in order to get and remain in touch with rivermen from whom much certainly would have to be learned in new territory, there being practically no accommodations near enough the fishing grounds to be made available. All of the localities named are mosquito ridden and I would not for a moment consider going into camp in such places without advance preparation in the way of large nets containing 20 square yards of cheese cloth each.

DISCUSSION

MR. D. B. FEARING, Newport, R. I.: I am very much interested in Mr. Worth's paper. Some 45 years ago, when I was seven years old, I lost my first striped bass, and I have fished for striped bass in many places since that time.

I was very much interested in what Mr. Gorham said about fishing in brackish water. I remember when a small boy going to a certain river in Rhode Island and seeing my father catch a striped bass with a fly, and I have records of the capture of striped bass in Great South Bay, Long Island, with the yellow sally and red ipis and the white miller; but the fishing in brackish water as an angler's pastime has all been transferred to the Pacific Coast. On the Atlantic Coast and in the east where I come from, I can remember as a boy at the West Island Club when it was a common thing for an angler to land 60 to 70 striped bass with rod and line in a day's fishing, fish that would run anywhere from 6 to 64 pounds; and as late as 20 years ago I saw 20 to 30 fish landed in one catch. At the present time you could fish from daylight till dark and never get a striped bass. There are gill nets that stretch from one to three miles in length straight out, and where there are no gill nets there are purse seines and pound nets. The striped bass in cruising around will strike one of the gill nets, but they will not go into them, turning instead and going straight out to sea. There is no angling for striped bass except after a storm which carries away the nets, and then good big striped bass are caught. But the old days when you could catch them with rod and reel are gone.

In California I have had many communications from the President of the San Francisco Anglers' Club, who was very much interested in the introduction of the bass out there, and in the fishing. Mr. Worth says they use herring for bait, but he writes that they find the best bait for striped bass out there to be the large clam, and when they cannot get this particular Pacific clam they troll for the bass with a spoon; and they claim that they will bite one curiously shaped spoon and will not look at another. Personally, I think the striped bass is a most extraordinary fish, as to what he will take. I have caught striped bass with pretty much everything, even with a finger-stall. I caught one that looked so fat that we cut him open on the rock and he had 5 or 6 menhaden heads in him, and mussels and all sorts of things, together with the stall that had been around a fisherman's finger to protect a cut. I had this stall tied on my hook and caught a bass with it.

If we could only persuade the legislators of the various states to pass a law forbidding the killing of bass on their spawning grounds, it would be a most excellent thing. You go into the New York and Washington markets and you will see cow bass loaded with spawn. You will see in the New York markets today bass offered for sale which are less than six ounces in weight.

The striped bass is a foreign fish to California. It was introduced in 1879 when 135 were turned out; in 1882 a plant of 300 more occurred and the biggest weighed only 8 ounces. In 1902 1,200,000 pounds of striped bass were sold in the San Francisco markets alone. It is the most successful introduction of a foreign fish that has ever been known. The people of California have protected their bass; they have a closed season for the bass during the spawning season, and it is against the law to take a bass under a certain size. On our coast we do that after the fish are all gone and there are none to protect.

MR. MEEHAN: Like Mr. Fearing I am a great friend of the striped bass and very fond of angling for them. It may interest some to know that I was probably one of the first half dozen persons to use the bloodworm for bait in the Susquehanna River. The first man to use it was Mr. Dercks, the gentleman mentioned in Mr. Worth's paper. Prior to that time clams and crabs had been used to catch the striped bass in the Susquehanna. A week after Mr. Dercks was there another man came from New York and fished, and I happened to see him going home. He had quite a bunch of bass and told me about the bait. We secured the bloodworms and used them with great success. In the first trip two of us caught in the neighborhood of 350 pounds in a trifle over a day's fishing, the average run of the fish being from 3 to 9 pounds. The heaviest bass that I caught myself was 15 pounds, and generally I would average one or two, possibly three, 12-pound fish in the months of July and September. It was pretty nearly a rule for men fishing there afterward to throw back everything under three pounds. The bloodworm was used in connection with a small trolling spoon, about a no. 4, and casting became quite prevalent there, especially in the

evenings, from the rocks above the station and on the Harford County side, on the right bank where most of the pools were.

Another fishing ground where striped bass are caught in some numbers is in the Delaware River above Trenton in the neighborhood of Scudder's Falls, Washington's Landing, and up as far as Lambertville, but the striped bass caught there are usually very small, rarely exceeding $3\frac{1}{2}$ to 4 pounds, although once in a while a fish weighing 12 to 15 pounds is taken. Bloodworms are used there.

In respect to the protective laws, the state of Pennsylvania classes the fish as a food fish and allows them to be caught with a rod and line throughout the year; but has a closed season so far as net fishing is concerned. Pennsylvania and New Jersey having concurrent jurisdiction over the Delaware River, combined and enacted a law which prohibits the catching of striped bass less than 12 inches in length, or more than 20 pounds in weight. Any striped bass over 20 pounds in weight caught in the Delaware River must be returned. That is on account of the Salem County end of New Jersey, where the large bass come in to spawn, and they are not caught for the purpose of permitting propagation.

MR. FEARING: I would add that the only bloodworm fishing that I know of around New York is on Long Island, although there are a number of New York anglers that make bluffs at it. But the South Side Sportsmen's Club on Long Island, at Oakdale, 10 years ago started in and found that striped bass could be caught with bloodworms, and now it is their greatest sport. They have a protected private series of trout ponds. There are about 110 members in the club; and they are only allowed to catch 15 fish a day. The fish are all liver-fed and will bite at anything, and there is no sport in it. In the striped bass fishing they are limited to 16. I forget how many years ago it was that they caught some 1,800 striped bass; and the biggest one ran $12\frac{1}{2}$ pounds; $7\frac{1}{2}$ -pound fish are caught with bloodworms and a small spoon, with a four-ounce trout rod; and it is the finest sport, I think, there is on Long Island.

MR. G. H. GRAHAM, Springfield, Mass.: I would like to inquire if they have ever fished with bloodworms for other fish besides striped bass.

MR. FEARING: They never have. I never used bloodworms as bait for anything except striped bass.

MR. GRAHAM: Why would it not be all right for black bass or salmon?

MR. FEARING: I think the bait is first class for black bass, but it is not always very easy to get bloodworms.

MR. WORTH: I have understood that this worm constitutes a considerable part of the diet of the striped bass when it is down in brackish waters in winter time—a natural food in the salt water. I was informed that it was impossible to fool a striped bass by using the common angleworm; that it could not be done; they would not bite an angleworm at all.

MR. FEARING: I have tried it and they will not take an angleworm.

MR. MEEHAN: On the Susquehanna River at Octoraro there are grounds famous for black bass and pike-perch. The latter species is known there as the Susquehanna salmon. On one occasion I saw a pike-perch weighing about five pounds that was caught by a fisherman while trolling with bloodworms; but I never saw or heard of a black bass being caught in those pools with bloodworms; although I did hear of a few that were caught by using just a single bloodworm. You see at that point they use, as Mr. Worth has said, quite a bunch of worms, seldom less than three or four. The worms are usually strung on two hooks, one placed above the other, and they hang from one hook to the other, making a large bunch, too large for a black bass. The particular pools at Octoraro are famous for pike-perch after the striped bass season is over, which ends in September in that section.

ARE THE HATCHERIES ON THE GREAT LAKES OF BENEFIT TO THE COMMERCIAL FISHERMEN?

BY S. W. DOWNING

We have often been asked, "Is the propagation of food fishes at the hatcheries really any benefit to the commercial fishermen and the fishing industry generally?" My reply has always been, "I certainly believe it is," and in this paper I will endeavor to prove the assertion.

At all the stations on the Great Lakes which are being operated for the propagation of the fishes most sought after by those who catch fish for market, the supply of eggs for hatching are all obtained from the fish caught for market by the commercial fishermen, the eggs being secured either by having men go out in the boats with the fishermen to strip the ripe fish as they are taken from the nets, or by purchasing the fertilized eggs from the fishermen at a certain price per quart. The number of eggs so secured necessarily depends upon the number of fish taken by the fishermen, and as the number of eggs collected from year to year has steadily increased, it is safe to say that the number of fish caught by the commercial fishermen has increased in like proportion.

To show the increase from year to year in the number of eggs received at the Put-in Bay, Ohio, station, I have formulated the following table, covering a period of twenty years, beginning with the year ending June 30, 1892, and ending with the year ending June 30, 1911, and showing the numbers of all kinds of eggs collected in the different fields operated by the Put-in Bay station:

<i>Year</i>	<i>Number of Eggs Collected</i>
1892	192,966,000
1893	83,214,000
1894	258,640,000
1895	518,460,000
1896	189,363,000
1897	96,743,000
1898	361,778,000
1899	678,840,000
1900	492,330,000
1901	636,244,000
1902	773,060,000
1903	485,119,000
1904	533,619,000
1905	816,664,000
1906	695,471,000
1907	1,055,629,000
1908	971,550,000
1909	1,046,646,000
1910	917,558,000
1911	1,115,585,000

The above table shows an increase from 192,966,000 eggs collected in the year 1892, to 1,115,585,000 in the year 1911, or in round numbers six times as many during the last year as during the first year of the table.

In some years the table shows an apparent falling off in the number of eggs collected, but the general tendency throughout the whole period has been upward. The smaller take of eggs could no doubt be accounted for by unfavorable weather just at the time the fish were spawning freely, as a few days at the height of the season often makes a great difference in the number of eggs secured. The falling off in the take of eggs in the years 1896 and 1897, the years showing the fewest eggs taken since the first two years, can be accounted for from the fact that during those two years no pike-perch eggs were collected.

The increase in the number of eggs collected at this station during the past six years would have been much greater except for the fact that during that time the take of eggs from the original territory has been divided with the Ohio State Fish Commission. An agreement being entered into in 1906 whereby the Ohio Commission was to collect the herring eggs and the U. S. Bureau the whitefish and pike-perch eggs, the fields formerly operated by the government

station for the collection of herring eggs were turned over to the Ohio people. Their collection of eggs from these fields has been as follows:

<i>Year</i>	<i>Number of Eggs Collected</i>
1906	228,640,000
1907	46,440,000
1908	84,470,000
1909	171,164,000
1910	285,960,000
1911	290,456,000

If this take of herring eggs collected from the fields originally operated by the U. S. Bureau be added to those mentioned in the table, a far greater increase would appear. The table shows that the average take of eggs for the first thirteen years, was 407,696,000, while the average total from the same fields during the past seven years, including the herring eggs collected by the Ohio people which rightly belong in these figures, reaches the enormous sum of 1,103,747,000, or a little less than three times as many as the average for the first period of thirteen years.

The greatest increase perhaps has been in the pike-perch work. The writer remembers that before this excellent food fish was propagated at the hatcheries, the catch had fallen off to such an extent that many of the fishermen did not set their nets for the spring catch, as there were not enough pike-perch being taken at that time to warrant putting the nets into the lake for the spring fishing. At the present time the spring fishing for pike-perch is the more profitable of the two seasons.

We believe that the above facts will bear us out when we say there is no doubt whatever but that the propagation of food fishes is of great benefit, not only to the commercial fishermen and dealers, but also to the general public as well.

DISCUSSION

MR. MEEHAN: I might say that to those figures should be added an average annual number of between 350,000,000 and 400,000,000 taken by Pennsylvania, which would swell that great total considerably. I do not think New York collected any from Lake Erie, but those figures

embrace lake herring and blue pike particularly, and whitefish from eggs taken mostly on the Canadian side, also some few taken in confinement by the fisheries department of Pennsylvania. As a result, the catch has greatly increased. In the Pennsylvania section alone, covering only 45 miles, the industry increased in eight years from a little over \$200,000 to \$600,000 a year, with a proportionate increase in the number of boats.

It may be said that you may travel anywhere along Lake Erie from one end to the other, and you will hear nothing but exclamations of enthusiasm with regard to the work of the United States and Ohio and Pennsylvania on Lake Erie, and what has been accomplished there. This is very flattering, since it so often happens that commercial men and others look upon the fish culturist and the fish protectionist as their natural enemies.

MR. W. O. BUCK, Neosho, Mo.: One point wherein this paper is especially gratifying is that it shows results from artificial planting of fish. That is to my mind a most important point. Merely working up a record showing that we have collected so many eggs and turned out so many fry looks very well on paper, but it does not amount to anything really, if that is the end of it. When we actually can find that the catch of fish is increasing because of our plants, it is encouraging.

And it is especially so, if results can be shown in the case of pike-perch because of the extreme delicacy of this fish. During the last two years I have handled pike-perch eggs, having had no previous acquaintance with them, and although a fair proportion of living fish have been turned out I have not found great satisfaction with them, because the fry are so delicate that I have feared they would perish soon after being turned out. I am not in position to know whether they did or not. Mr. Downing, being in charge of the collecting work, knows what he is talking about when he says that his work has produced results.

MR. MEEHAN: While this Society was in session at Washington in 1908, I received a telegram from the city of Erie, saying that the boats brought in so many herring that the dealers were unable to handle them. Word was sent up town to the people in Erie to come down and take away what they wanted. There was a surplus of 25 tons. That was the beginning of the big jump. The following year the dealers filled their houses very promptly, or nearly so, and they issued orders to the boatmen not to bring any more than an average of three tons of herring per day. They cut out half their nets for several weeks. They did the same thing last year for about a week; so that the increase was very marked in the catch.

MR. DOWNING: I would like to cite one other instance where it is proven that the planting of fish is a benefit.

One season while I was in charge of the Alpena, Mich., station, I collected pike-perch eggs at Saginaw Bay. A part of the fry resulting from these eggs were returned to the waters of Saginaw Bay, and the

balance were planted in Thunder Bay about twelve miles out from Alpena. I was soon sent away from Alpena, and about four years after having made the plants in Thunder Bay, I received a letter from a man both a dealer and fisherman, who, while I was at Alpena used to blackguard me a great deal about getting money that I was not earning, as I was in the government employ and having a snap, and asking me what I did with all those millions of fry that I claimed to have hatched.

In the letter, he inquired if I could tell him how he could get some more pike-perch fry planted in Thunder Bay, saying that that year, beginning with the first lift of fish in May, the take of pike-perch in waters where they had not been known before had ranged anywhere from 1,500 pounds to three tons at a lift from 4-pound nets, and continued until November, when he took his nets out.

MR. MEEHAN: In 1904 a man at Sunbury on the Susquehanna applied to my department for some pike-perch to be planted in the river. The stock had been distributed, and all that I had then were some blue pike, which were just coming in. I told him that I had no pike-perch or "salmon" as he called them, but did have some blue pike, very much the same, in fact, said by ichthyologists to be the same thing, that I would send him. I sent him a supply which he planted. Three years later I began receiving letters from the neighborhood of Sunbury, from between Sunbury and 15 miles below, asking whether I had heard about anything being wrong with the Susquehanna salmon; the people were beginning to catch quite a number of fish of a peculiar bluish tinge and thought they were totally unlike in color to the "salmon" in the Susquehanna, which were called yellow. They would have thought that the fish were diseased, only they struck the hook and fought as vigorously as did the salmon. Did I know what was the matter!

Blue pike are being caught in considerable numbers from Williamsport down to a short distance above Harrisburg, and it is considered today to be rather more abundant in the Juniata, in the Huntington and Blair County section, than the Susquehanna section itself, where it is today known and called the blue pike as distinguishing it from the Susquehanna salmon.

DR. TARLETON H. BEAN, Albany, N. Y.: New York is not doing as much in the hatching of eggs from Lake Erie fish as it expects to do in the future, because New York has no suitable vessels for egg collecting on that lake. For the past few years small numbers of lake herring and blue pike have been developed at Bemus Point, on Chautauqua Lake, and Caledonia. I need not say to any expert fish culturist that it is pretty difficult to do the work at long range without a suitable collecting vessel. Still, if I remember rightly, the plant last spring from those two stations was not less than 30,000,000 of lake herring and nearly as many blue pike. We are, in fact, just beginning.

Our pike-perch work is done chiefly at Lake Oneida, where we have no difficulty in taking upward of a hundred thousand gravid fish in a

season. Last spring, in May, the Oneida hatchery had 1,200 quarts, each quart containing 150,000 eggs; that hatchery was completely filled with pike-perch eggs, and there was a surplus of 300 quarts taken to Caledonia and hatched there.

Naturally we did not deliver all our pike-perch to the Great Lakes. We know that the planting in the inland lakes, small and large, have been extremely successful, and the anglers are delighted with the results obtained from the planting of the pike-perch fry.

Many of our lakes furnish excellent fishing, as, for instance, in Chautauqua, where no pike-perch were ever found before we planted them there. I could name a dozen lakes throughout New York state in all parts of it, east and west, which are now open to the angler.

There is no doubt about the success of planting pike-perch fry or lake herring in the state of New York. We have a substitute for the lake herring and a very good one, too, in the tullibee—a rather small but beautifully-shaped lake herring. It is the same as the tullibee which was originally taken in Onondaga Lake. It has apparently left Onondaga Lake because of the pollution of the water by the manufacturers. Or it may have been a resident of Oneida Lake and was not discovered by the expert fishermen there until recently. We hope next fall to take enough eggs in Oneida Lake near the station to fill the hatching jars.

MR. MEEHAN: We have been very successful in Pennsylvania in planting pike-perch fry averaging about three days old, in the smaller lakes of Pennsylvania, which are all very small except two or three, at least they are small compared with the larger inland lakes of New York. But a very remarkable example of the success is shown in Conneaut Lake, the largest lake in Pennsylvania, about four miles long and a mile wide. Pike-perch were planted there in the 80's, and subsequently until about two years ago no one knew how to catch them. It developed that they were there when we set our traps for muskallunge, for the traps were pretty well filled with pike-perch every day. We have taken eggs there for the last two years, obtaining from 4,000,000 to 6,000,000. Last year reports came to me of over 1,500 pike-perch caught with rod and line at Conneaut Lake.

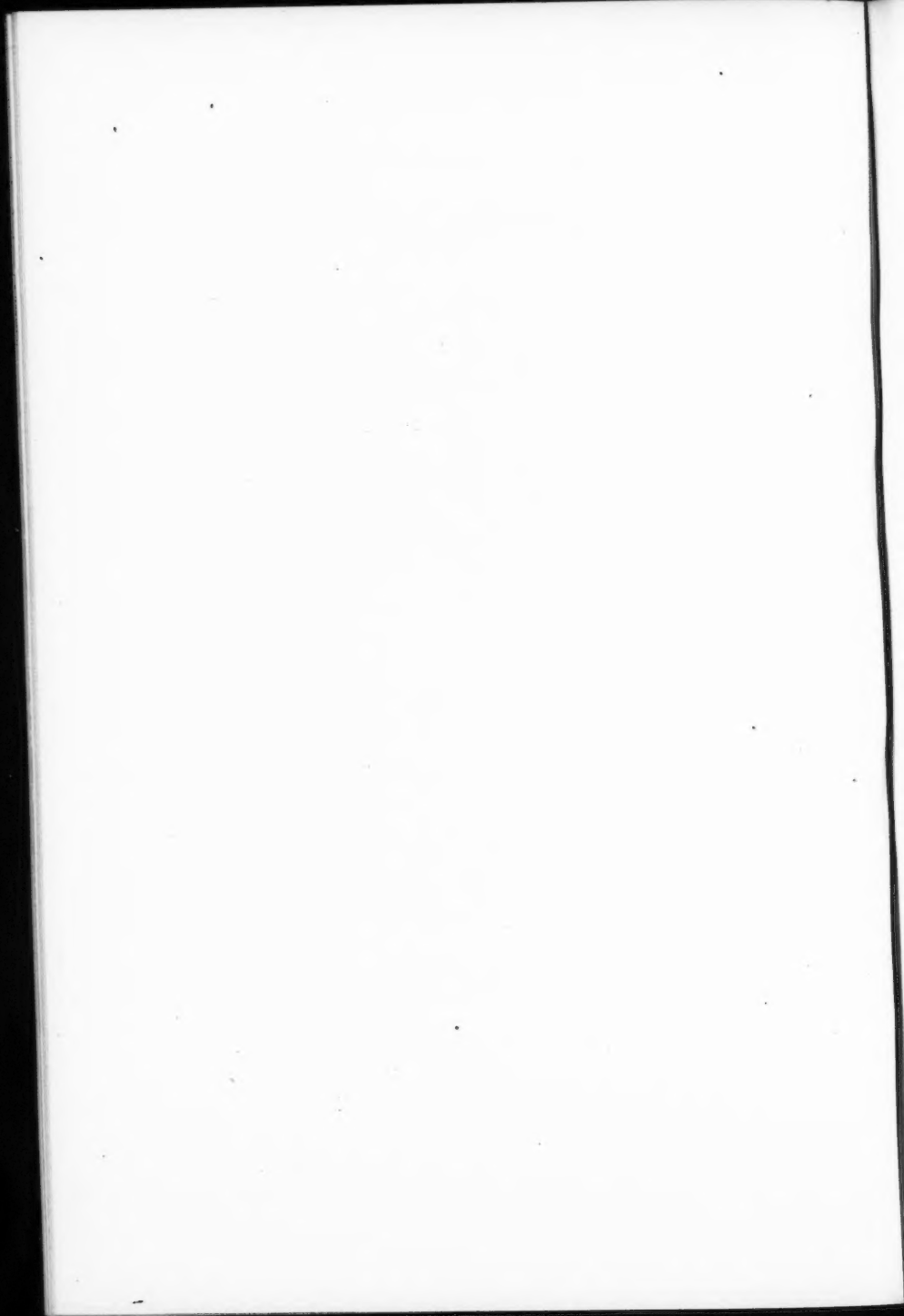
MR. G. H. GRAHAM, Springfield, Mass.: I would like to ask Dr. Bean if he considers it a good plan to plant pike-perch in lakes in New England that at the present time contain black bass and pickerel?

DR. BEAN: We do it in New York, because the pike-perch, black bass and pickerel are natural associates. You will find them almost everywhere, throughout our state at least, always associated. On the assumption that nature knows best what fish will live together in harmony, we follow nature; but we never plant pike-perch in a lake which contains trout, or any member of the salmon family. We reserve the pike-perch for bass lakes and yellow perch and pickerel lakes.

MR. MEEHAN: That is the system with us. We find that the three fish have practically their own domains, the bass being in one, the pickerel

in another and the pike-perch in a third. So that they seldom interfere with one another. Occasionally the pickerel and the bass will get into a scrap, in which case the pickerel gets the worst of it; but we have never found that the pike-perch interfered in any way with either the bass or the pickerel. Their habits are to keep close to the bottom and among the rocks and in the deeper water, while the bass are among the rocks, but in the shallower parts of the lake. The pickerel are in the muddier parts of the lake among the weeds and leaves.

DR. BEAN: I might add a word on that subject. The spawning habits are very different for those three fishes. The pickerel runs up into the bogs in a few inches of water, casting its eggs in masses just after the ice leaves, the bass is a nesting fish, and the pike-perch goes up into the little creeks, spawning at the surface naturally, the female fluttering about near the top of the water and attended by four or five males. Again, the eggs are different, very different indeed, in every respect, so that there seems to be a natural provision for associating those fish in the same waters without injury to any.



ATLANTIC SALMON IN FRESH WATER

BY CHARLES G. ATKINS

In the fish-cultural work of the Craig Brook station the Atlantic salmon has always been the leading species; and the methods adopted, which have been essentially different from those pursued with any species of salmon elsewhere, have afforded data for some interesting and important biological deductions.

The methods pursued are in outline as follows: Brood fish are secured each year by purchase from the weir fishermen located on the tidal portions of the Penobscot River and are conveyed immediately to a roomy enclosure in a small fresh-water stream. Here they remain without food and without other care than such as is necessary to guard them against escape from the enclosure or destruction by human or other foes, until late in the month of October, when the earliest of their eggs are mature. Artificial work, after the usual methods, relieves them of their eggs. Spawning is nearly always completed before the middle of November, and then the salmon are liberated—commonly in tidal waters.

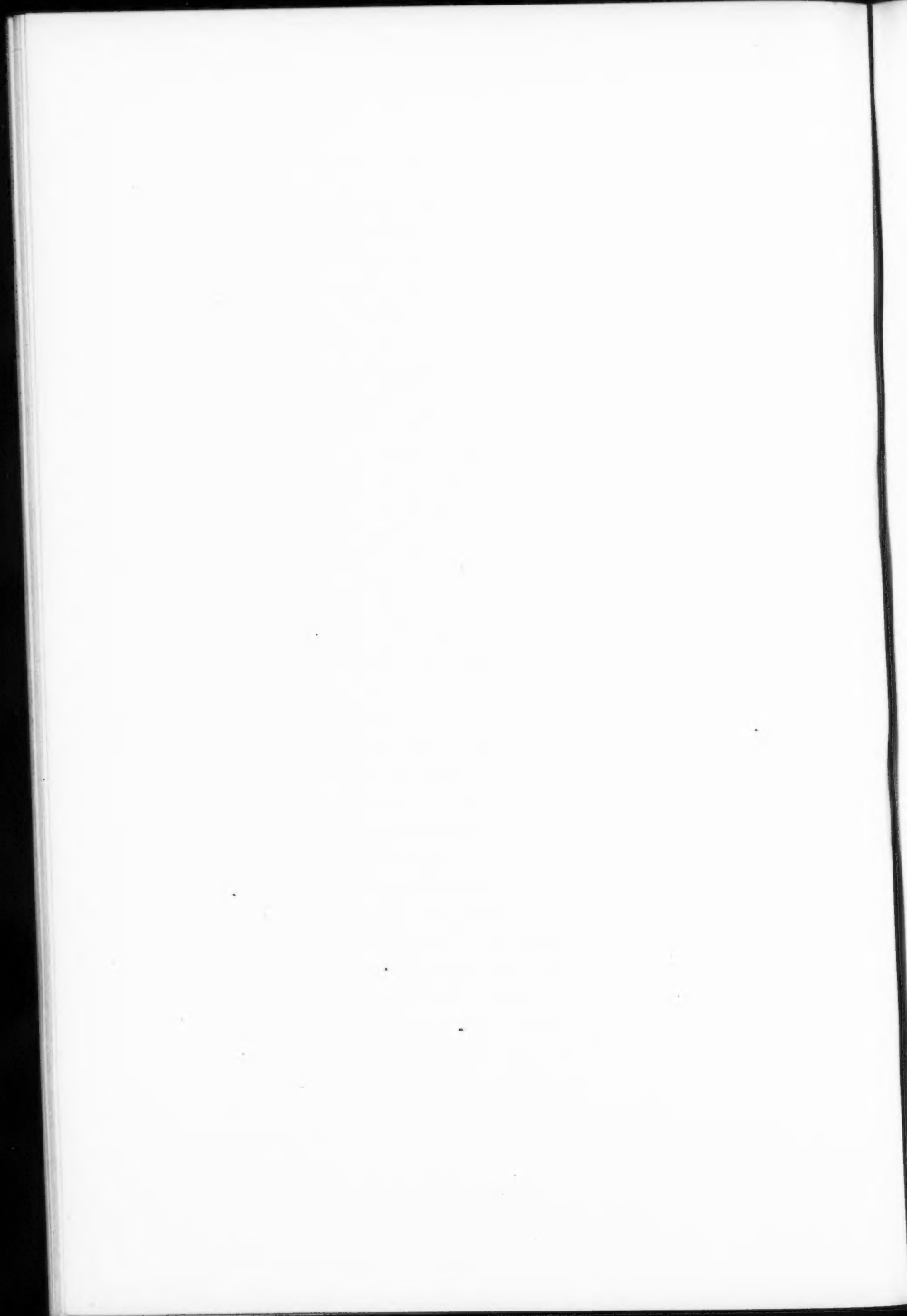
The collection of brood fish is always made in May and June, and at that early date it is found that the external appearance of the two sexes is so closely alike that it is impossible to distinguish males from females, and they are therefore bought indiscriminately. In September, however, it is found that the sexes have developed peculiar features which afford ready distinction between the sexes. At the spawning season it is always found that there are more females in the enclosure, an extreme instance being the brood of 1910, when out of 693 salmon there were 436 females and 257 males. In some other countries it has been reported that there is a predominance of males.

Early in the history of the station, studies were made on the question of the survival of the salmon that had spawned

and their subsequent return to the river. The liberated salmon were marked by metal tags attached by wire to the rear margin of the main dorsal fin. Each tag was stamped with a number which referred to a record of all important facts relative to each fish, so that on recovery of a marked salmon it was possible to follow its history back to the day of its spawning and compare its length, weight, etc., on each occasion. This experiment was carried on for several seasons, and in all over 1,200 salmon were marked. Nearly 40 of these were recovered with the tags on. A few of them were recovered in the spring following their liberation, and the condition of these fish showed that they had been lingering in the river and had taken little or no food. The most of them, however, were retaken during the May and June of the second season following their liberation—that is, two years after their first capture; these salmon had fully recovered from the emaciation of the spawning season, and measurement showed that in each instance there had been an increase in length. Several of these recaptured fish were females and in the autumn gave a second litter of eggs. It is probable that the 40 recaptured fish were only a small portion of the actual survivors out of the 1,200 marked; for it is altogether likely that most of the tags dropped off. Indeed, it seems a wonder that any stayed on, considering the long time that had elapsed and the constant motion to which the tags were subjected, swinging back and forth with every movement of the fish. It being thus established that Atlantic salmon return to the river a second time for procreation, being then 6 years old, it is not improbable that a few of them return again, spawning the third time when 8 years old, and quite possible that in rare instances the process may be repeated a fourth time at the age of 10 years.

It has until recently been supposed that the recovery of a salmon from the exhaustion of the reproductive process required absolutely a return to the sea and a sojourn of some months in its natural element, with access to its natural food. It was therefore without any expectation of a

favorable result that the experiment was tried of retaining salmon in fresh-water ponds for several years after their first spawning. In November, 1908, some salmon of both sexes were after spawning transferred to one of the artificial ponds at Craig Brook, and 8 of them were retained for this experiment. Three of these fish died in June, 1909, and one more in September. The remaining four lived through to the spawning season of 1910. For the first 10 or 11 months of their stay in the pond they refused to eat anything, though often offered small herring and other food. In the fall of 1909, however, they began to eat and showed good appetites, eating through the winter. When the spring of 1910 opened they began to eat ravenously and continued to do so until about July 1, when their appetites began to fail, and in a few days they wholly ceased to eat. The food taken had evidently improved their condition, and they came to the spawning season of 1910 in as good condition (excepting one fish) as is usual with salmon that have been confined a single summer. There were found to be two males and two females. On November 2 they were subjected to the usual process of artificial spawning. Both of the males were found to be in normal condition, yielding milt as usual. One of the females was sickly and gave inferior eggs which never hatched. The other female appeared to be in normal condition in every respect; her weight was fully up to the average for salmon of her length (32 inches) and her eggs were of prime quality, for they developed as usual and hatched a normal proportion of fry which have thrived through the first summer fully as well as any others. After spawning, the two males and the best of the females continued to live, ate nothing for several months, recovered their appetites in April and May, eating well until about the middle of July, when they ceased eating, and have continued to abstain from all food until the present writing, September 28, 1911, without showing any unfavorable result.



CONTROLLING THE MOVEMENTS OF FISH

By W. O. BUCK

The essentials of fish culture are three: food, water and control. Indeed, since everything alive needs food and water, mention of these might be omitted and the assertion made that the essential of fish culture is control.

We realize the need of regulating water-supply for the purpose of preventing interference, of things animate and inanimate, with our fish from the egg to the adult stage. Attention is invited to the equally urgent need of controlling their movements.

To catch adult fish we study their habits and pit our wits against theirs. Even when we seine them this is partly the case, though it is then more a question of main strength and stupidity, the fish being supposed to furnish the stupidity, although it is to be feared they are not always allowed a monopoly of it. And here is a point at which improvement may be made. Wherever it is at all practicable the fish should be led to go where they are wanted rather than dragged thither.

It is unnecessary to expatiate on the disadvantages of seining fish ponds because that is realized. The suggestion is that we get at some better method, instead of plodding along the same old wrong path. When eggs are hatched in jars the fish swim over of their own accord to the collecting tanks and are held by screens. Most fish culturists will recall the thrill of horror with which they have at some time or other found this literally true; that is, the fish were held by the screens instead of by the tanks. Here we start right by allowing the fish to follow their impulse to go with the current and should go further and hold them where we want them by offering no road out. It is not sufficient to provide the road and blockade it with a screen. The screen being a necessary evil should have as large a surface and as

little current as practicable. Where a long trough is used for a collecting tank the screen may be lengthwise instead of crosswise, thus giving vastly more surface and correspondingly less current through it at any point.

Advantage may be taken of other impulses also to keep fish away from the screens. Trout fry shun the light and will seek the middle of the trough if that part is dark. Pike-perch fry are very active from the first and seek the light and may be attracted away from the screens by a bright spot elsewhere. In ponds young bass seek the current and struggle to pass screens and it should be practicable to take advantage of this fact and collect them without need of seining the whole pond or any considerable part of it. By a suitable arrangement of ponds and pools and adjustment of screens of different mesh the young fish might be collected and separated not only from the brood fish but from those of the same season but different size. Fear is a great help to a small fish in the business of getting through a small hole. If desirable to hold young fish in the breeding ponds, it may be best to reduce or cut off the overflow. This is sometimes the only practicable way, since a screen fine enough to stop the smallest fish will be sure to clog and overflow or to catch the young fish attempting to pass it. This point is especially urged. Reduce the inflow until there is little or no overflow.

It may be claimed that the food for the young fish is brought to them in the water-supply and the inference drawn that the greater the flow through the pond the more food there will be in it. If this were true, it evidently would not do to cut off the supply. But it seems reasonably certain that fish food is produced in greatest abundance in quiet, warm water. Within limits such water will answer for young Salmonidæ and it suits bass exactly. A temperature of 70° F. is warm enough for adult trout and salmon, but the young will bear 83° F. Adult bass will seek cooler water when the temperature reaches 90°, but 92° does not appear harmful.

Perhaps insect food does not travel so fast nor so far as we are apt to suppose. Quite possibly these creatures which breed in running water find shelters there and mostly remain in the stream. Probably insect food should be produced where the fish can find it rather than where it must be carried to them either in the water-supply or otherwise. Fortunately in bass culture the conditions which favor the production of insect food suit the young fish also. It may be that a reason for the good results obtained with large ponds for bass is the greater proportion of warm, quiet water existing in such ponds, since it may easily happen that the increase of water-supply is by no means in proportion to the increase of pond surface.

Number and kind of plants, the shape of the pond and configuration and quality of its bottom as well as amount and position of intake and doubtless many other conditions affect results, and it may well be that these varying conditions account for the difference of faith and practice of fish-culturists as illustrated in the fact that some find it necessary to sweep as soon as the young are large enough to be handled while others leave the young in the brood ponds until fall and have good success. Some who leave them till fall mention that the young are all of about one size. This fact would not justify an inference that there had been no cannibalism, but rather suggest that all smaller had been devoured. Sorting is a recognized means for control of cannibalism. But where the young are taken out and placed in a pond by themselves losses continue and to an extent which would be considered ruinous in any other business. An illustration of this is the case mentioned by Mr. Titcomb in his "Aquatic Plants in Pond Culture," of 6,000 fine fingerlings being taken from a pond into which 20,000 fry had been put eight weeks before.

The inference is not far-fetched that the same thing may be true when the young fish are planted. Here, however, there are two things for our encouragement. The fish

are supposed to be so placed that they can make their escape by scattering and we may, if we will, help this along by wide planting. Then, too, if we are made that way, we may perhaps believe that young fish do not eat one another after planting because we do not catch them at it. This sort of argument is not wholly satisfactory to some persons, but all too much of fish-cultural practice has nothing more substantial behind it. It is not the present purpose to more than allude to the all-important question of what becomes of planted fish, the problem just now being how to get the greatest number in possession for planting, and two suggestions are offered.

1st. In both tanks and ponds prevent fish from escaping into the current by having no such current within their reach.

2d. As a help in prevention of cannibalism make the fish sort themselves by giving them opportunity to pass screens of various mesh into separate enclosures.

This latter idea has not yet been worked out and put into successful practice although it is not new. The principle is much the same as in Mr. Snyder's screens for sorting trout, except that in these the motive power of fear is applied by moving screens until the fish are crowded, while for bass in ponds pursuit by larger fish would provide the impulse.

In controlling overflow a practical point requiring attention is that of getting flash-boards entirely tight, or substituting something for them which will be tight. Professor Dyche and Mr. Cotte use outlet pipes of a U shape, one elbow screwed on practically tight but loose enough to admit of turning. The water-level is determined by the angle at which the elbow is set. Control of the overflow being provided, current and thereby the movements of the fish may be controlled at the intake.

DISCUSSION

PROF. L. L. DYCHE, Pratt, Kan.: Mr. Buck referred to the manner in which we control water through certain pipes at the Kansas state fish hatchery. The method in the old hatchery is not satisfactory, and the new hatchery which we are planning will be under a different method altogether. The water will be allowed to flow from one pond to another through pipes and cement gateways which latter will be two feet nine inches wide; these gateways will have at either end places for putting in flash-boards, and other places for putting in wire screens. The screens will be made of three-inch mesh, half-inch mesh or quarter-inch mesh, and very fine screen mesh, as fine as is necessary, to control the fish or keep them from passing through the screens. This will admit of free passage of the water through these passage-ways from one pond to another, and it will be under control.

In this new hatchery we plan to have all the ponds connected, as indicated above. We like large ponds, but not too large. We like a pond that can be drained easily, and these ponds will be so arranged that each one can be drained independently without any interference with any other pond. Many of them are arranged in pairs, so that when we put breeders in a pond, it will be possible for the younger fish to pass through the gates into the next pond. We plan to have V-shaped screens that will allow the young fish to pass through between the fine wire screens, through a narrow slit; then they can swim about and feed in pond number two and not be able to get back where the old ones are. Experiments have shown that the young fish will hunt a very small outlet. At the Kansas hatchery we discovered that many young fish had passed from a breeding pond to a retaining pond where we did not want them. On examination we found a pipe covered with wire screen. The meshes of the screen were a little coarse, and were large enough to allow the small fish to run through, and thousands of them came through there, though the pipe through which they passed was only three inches in diameter.

The above experience suggested a number of things to us in regard to the moving of fish from a breeding pond into a pond where they could be cared for and handled by themselves without disturbing the old fish and without disturbing the young fish, and it undoubtedly had something to do with the ideas that guided us in the planning of a new hatchery. It furnished an idea of how fish might be handled through the entire system of ponds in the new hatchery, which will embrace more than a hundred in number when completed, and will be so arranged that fish can be moved from one pond to another without handling them. One acre has been adopted as the standard size for ponds, but as a matter of fact the size will vary from one-half to one and a half acres in area. In the system we are trying to develop, any one of these ponds can be drained independently of any other pond, and can be drained, if necessary, in 24 to 36 hours, and can be filled in 24 hours. Any pond can be shut off and the water can be made

to flow through other ponds, making it possible to do something with a pond in a very short time, if necessary. This idea will be worked out in the pond system of the new hatchery.

What Mr. Buck referred to had to do with the old hatchery, rather than with the plans that we are developing for the new one.

MR. BUCK: Have you followed your experiment through of holding young bass or trapping them in a V-shaped screen with a small opening between? I tried quite a number of experiments to trap them in that way, and I found they did not pay any particular attention to the fact that the screens were V-shaped. They could as easily go through one way as the other; they could see that way and would go right through. I did not succeed at all in trapping bass with any such arrangement.

PROFESSOR DYCHE: I do not see how they can get back. They would swim by. I have used the same kind of a device for the trapping of minnows, and it worked successfully.

MR. BUCK: That is the theory, but they did not do it. They went back and forth freely.

PROFESSOR DYCHE: When the young fish go through the trap gates into the new feeding grounds, they may be shut up there. The trap gates need not be left open except while the fish are going through. The small bass, when they begin to swim about, will go with the water that is going out, and every one that comes along apparently goes out. After they get larger and stronger and, say two-and-a-half inches long, they seem more willing and able to go against the current; however, by this time the passage-way may be closed so that they cannot go back to the breeding pond where the old ones are. Such an arrangement, so far as I have been able to work it out, seems to be a good one. If this system is not altogether satisfactory, the pond system will admit of almost any kind of an arrangement for almost any kind of work that one may want to do. One can connect a number of the ponds or can have them all independent. One can handle the water as one sees fit; the ponds are built small, averaging an acre in size. We will have a hundred ponds, which will give a great deal of perimeter—a vast amount of shallow water, where the proper kind of plants can be grown and where other natural conditions favorable to the fish can be produced. We do not want to interfere with the fish any more than is necessary; we want to let them alone. We hope to provide conditions that will encourage the fish to do just what they want to do, to breed and produce their kind. That is the idea of building ponds having considerable perimeter. These ponds are basin-shaped; and when the water is at its normal stage it will be six feet in depth at the deepest places and the places where the ponds are to be drained.

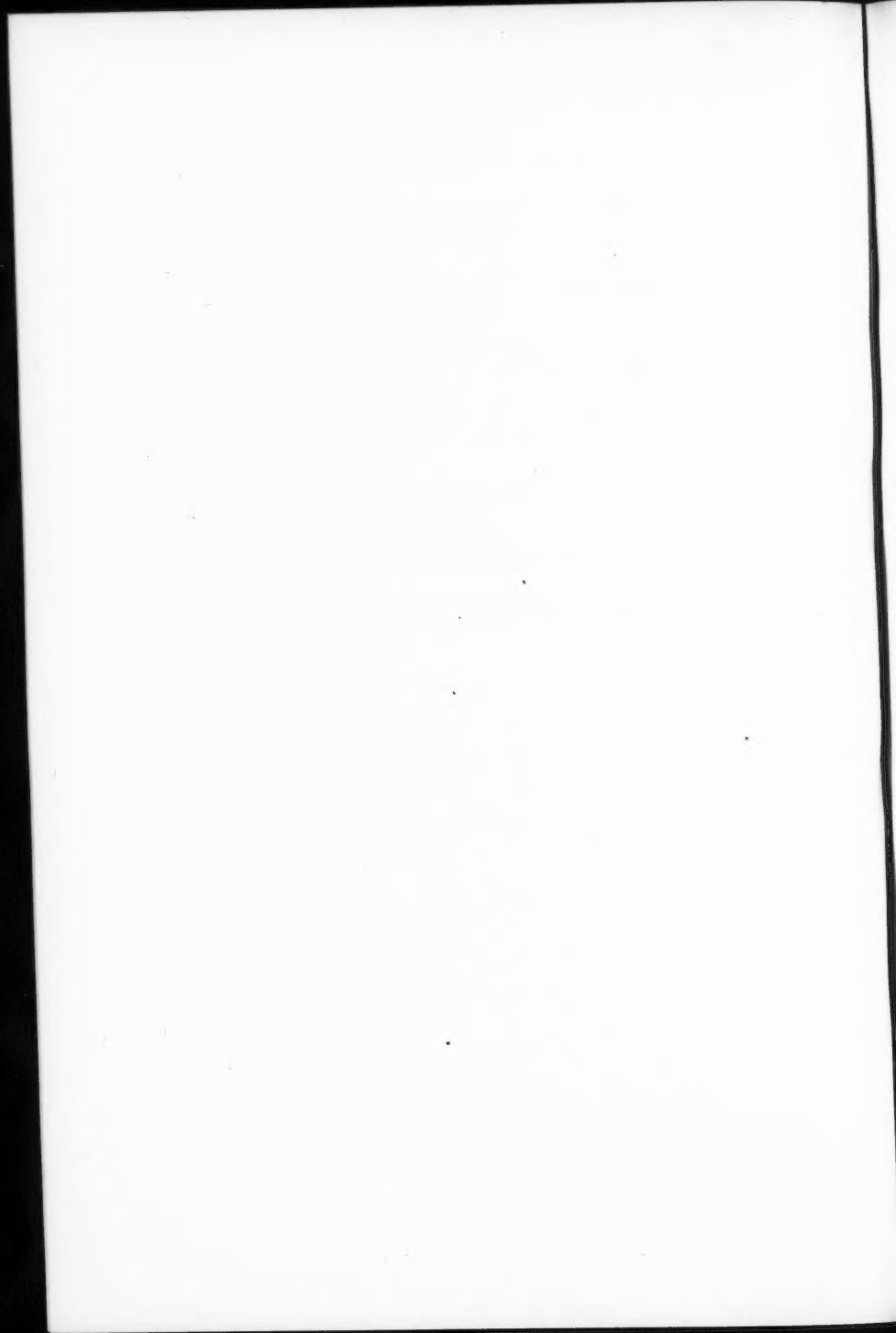
MR. G. W. N. BROWN, Homer, Minn.: At the Homer station, the outlet or drain boxes are provided with a cement partition, which affords perfect water control. Suitable openings are provided at a proper height to allow the overflow to pass out when the pond is filled,

also for maintaining different water levels desired or for drawing down the pond. A recess in the front side of the partition is provided to admit a board, in sections, for closing the openings, thus effectually preventing leakage. This method is recommended where it is necessary to economize water.

PROFESSOR DYCHE: I do not know that I caught the first of Mr. Brown's remarks, but these ponds are all connected one with the other by cement runways in which flash-boards and wire screens can be placed. The height of the water in any pond can be regulated by the height of the flash-boards. There is a system of pipes for water supply and drainage purposes, none of which are less than eight inches in diameter; these pipes will carry the water into the drainage of waste pipes and from pond to pond.

The drainage pipes take the water from the cement basins and from the deepest places between the ponds in the runways. One can see and know what is there before the water is started through the drain. The screens, when properly placed, will protect against the loss of any fish.

It is possible to know the condition of things all the time, since all these ponds are built independently of each other and can be so used as independent ponds; or they can be connected two or more together, if so desired.



EXPERIMENTS IN REARING BASS FROM NO. 1 TO NO. 2 FINGERLINGS

BY DWIGHT LYDELL

As the applications for bass in Michigan have been increasing at a remarkable rate during the last few years, it has become evident that something must or might be done to supply these applicants with fish. As no money was available for enlarging the plant and thereby increasing the output, and as nearly all applicants expect at least four or five cans, it occurred to me that if our bass of three-fourths to one inch in length, and put up at 500 to 1,000 to the can (according to the distance shipped), could be reared to about two inches in length and shipped at 250 or 500 per can, at least one-half more applicants could be supplied and they would be as well or better satisfied.

Anyone not familiar with the feeding of young bass of the length mentioned above has no idea what he is up against until he attempts to raise a few thousand. It is easy enough to teach the adult bass to take liver when cut up into strips to resemble a worm when sinking, but to prepare liver in this form for thousands of one-inch fish would be an endless task.

Unlike most other fishes, the desire of the bass, both large- and small-mouth, is for something moving, something alive. This makes it doubly hard for the fish culturist to find a prepared food or to prepare one that the bass will take in quantities large enough to make them grow rapidly. At the Mill Creek station in Michigan, where over one and one-half millions of bass in the various stages from advanced fry to no. 3 fingerlings are shipped each year, experiments in feeding the one-inch fish have been carried on during the past season with ground liver, beef, crayfish, clam meat and suckers.

Liver proved to be out of the question, as the bass would take only enough of it to keep them alive, and did not grow. Beef was a little better, but expensive. Suckers were tried with success, but as the source of supply was uncertain this food was discontinued. Crayfish the bass would take in almost unlimited quantities, and as we had an abundance of crayfish these were used almost wholly. Clam meat was tried with equal success and an abundance of this food was obtainable for the Mill Creek hatchery from the clam fishermen who supply the button factory with shells.

Our fish were kept in a small pond about twenty by forty feet, with natural sand sides and bottom. The crayfish after being run through a common meat grinder were fed to the fish every two hours for the first several days and they were given all they would eat at each feeding. After several days they were fed only four times a day or about every three hours. When fed in the above manner for four weeks they attained a length of two inches, when they were distributed. For lack of small ponds for rearing purposes only 2,000 fish were fed in this way.

BRIEF NOTES ON POND CULTURE AT SAN MARCOS, TEXAS

By JOHN L. LEARY

It has been observed at the San Marcos, Texas, station that during the past ten years the spawning season of the large-mouth black bass has without exception begun each season during the period of ten days from February 8 to 18. The average temperature during this month has ranged from 58° to 64° F. Crappie, bream, and rock bass begin spawning later, during the month of March when the temperature gets to be about 65°, though during the spawning period from the middle of March to the middle of May it may vary from 62° to 68°. It is when the temperature ranges from 65° to 68° that the fish spawn in largest numbers.

There appears to be quite an analogy as regards the season for spawning of fish and the blooming of plants and trees. However, this is no doubt due to the fact that atmospheric conditions suitable to development in the one case are equally applicable in the other. The cause and effect are common to both.

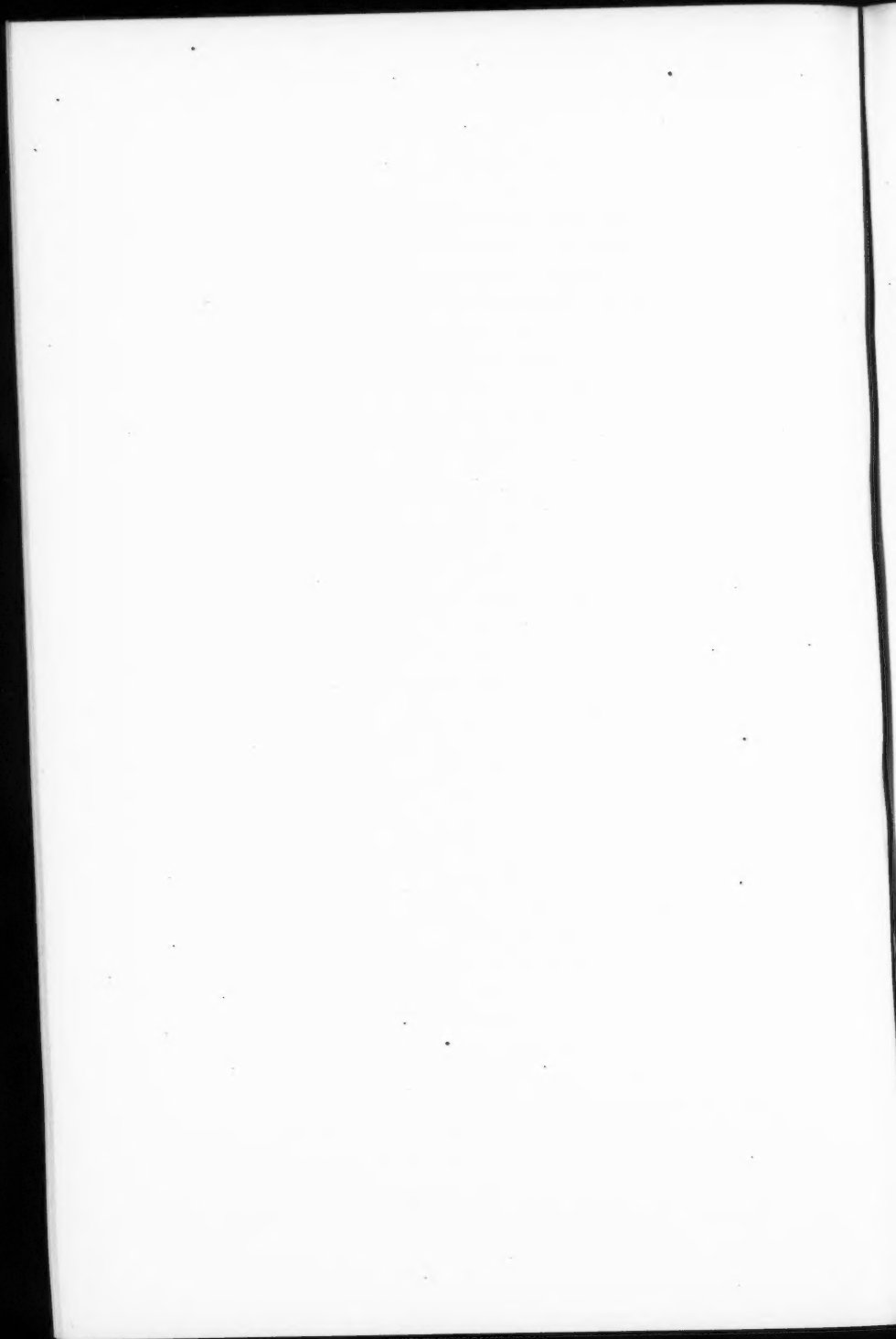
In the locality of the San Marcos station black bass are the first fish to spawn and the following trees and shrubs bloom about the same time: white elm (*Ulmus americana*), red bud (*Cercis occidentalis*), and the Mexican buckeye (*Ungnadia speciosa*). The elm is the earliest of the three, but all, however, bloom about the same time that the bass spawn, giving the idea that when these trees bloom the spawning season for bass has arrived, whereas, of course, it is the atmospheric condition that promotes both blooming and spawning. It is an accepted fact among the fishermen of North Carolina that the big runs of herring do not come into the sounds until the dogwood (*Cornus florida*) blooms, or about the middle of April; also that no sturgeon make their appearance until this tree blooms. Again atmospheric con-

ditions play their part and produce the proper conditions for both the blooming of the tree and the spawning of fish. And as for the sturgeon, they follow the herring for the sake of their spawn, on which they feed, taking as they do their food by suction. The spawn of herring or any other fish makes an appetizing meal. These conditions, however, give rise to the idea that when the dogwood blooms there will be a run of herring and sturgeon. This nearly always proves to be true. The dogwood sign does for the fishermen, but they fail to realize that fish do not spawn until water temperatures become suitable, and that the spawning season varies with atmospheric conditions controlling to a great extent both water temperatures and the blooming of plants and trees.

Next I will give some brief observations as to the nesting of black bass. I am sure that the male does not in all cases build the nest; he is quite often helped by the female, for when the season and conditions of water come around they pair off like many birds and water-fowl and both assist in building the nest. But it might so happen, and often does actually occur in pond culture that in stocking the ponds the fish are not evenly paired—possibly more males than females—and the unpaired male has to work alone. After completing his nest he must look up a female, taking possibly some weaker brother's mate and thus causing the fights we so often witness without realizing the exact cause. The same may occur if females predominate. I further believe that when conditions of fish and water are right a male or female without a mate will nest and spawn, and that is why we so often see a nest with nothing on it, or a nest with the entire lot of eggs worthless. I firmly believe that nature asserts herself more strongly in the lower orders of life than in the higher types, and I feel sure that unless fish find the right location and suitable water conditions the results from spawning will be rendered abortive.

Now for some hints on pond building. I will say that if I were to lay out another pond-cultural station, I would not

build a pond under one acre in size, and if water conditions justified I would make them much larger. The depth I would vary with climate, but always so that the ponds could be drained absolutely dry. In building banks I would make the long slope on the inner side. The ponds should be so located that an abundance of water can be supplied without the use of machinery or at least so that the ponds can be kept full by natural gravity flow, even if it is necessary to empty them by machinery, as pumping out once a year is much cheaper and much better than having to pump continuously to keep ponds to a standard of fullness. As to shape of ponds, just conform to the lay of the land; this will make them both more effective and picturesque. As to nursery ponds, if I intended to hold great numbers of fry to the fingerling size, I would build them several acres in extent and very shallow, say an average of about three feet with a slight increase of depth toward the draw-off. I still believe that it pays to stock all inland waters with fish from $1\frac{1}{2}$ to 2 inches long.



SOME OBSERVATIONS ON THE CULTURE OF YELLOW PERCH IN PONDS

By W. B. GORHAM

The following facts concerning pond culture of yellow perch (*Perca flavescens*) were noted while the writer was acting as fish culturist at the Erwin, Tenn., station. As many ponds unsuited for the propagation of the basses could be utilized for the culture of this other excellent fish, it seems possible that these facts may prove of interest to the members of this Society.

Upon my arrival at this station our brood stock of yellow perch consisted of one pair, about eight inches long, that had been saved from a consignment of bass brought by car from Meredosia, Ill. During my stay they received no particular attention, the other warm water fishes being given precedence in every way, yet from this little family about 2,000 fine healthy fish were distributed annually.

The pond in which they were reared was of the dumb-bell shape designed by the late William F. Page and of small surface area, being about one hundred and twenty feet long by thirty feet wide and contracted in the centre to a width of ten feet. The extreme depth at one end was twelve feet, shoaling to eighteen inches at the further end. The banks were for the most part rather steep, and were fringed with willows, the roots of which, with hair-like fibres, extended well out into the pond.

The fish spawned early in the spring at this station, the eggs being deposited in conglutinated masses on the willow roots, in water of an average depth of five feet through, the roots floating about eighteen inches from the surface. The eggs soon hatched, usually in ten to twelve days, the small fry hiding, and appearing later in schools as fingerlings, when they could sometimes be observed feeding along the shore line, if one used extreme care in approaching the pond. The adults were always left in the pond with their

young, and from the number of young reared to fingerling size and shipped it would seem that they cannot be very cannibalistic. The adults were never fed, as far as I know, and as I have before stated were given little or no attention.

The ease with which yellow perch are reared, their good qualities as a food fish, and their ability to stand transportation, which they do better than any fish I have ever carried on messenger trips, all lead one to believe that their culture in ponds would be well worthy of undertaking.

A NEW AND ENLARGED FISH HATCHERY FOR THE STATE OF KANSAS*

BY L. L. DYCHIE

I might say, gentlemen, by way of introduction, that I am from Kansas and that I have been connected with the Kansas State University in one capacity or another for a period of 34 years. At present I hold the chair of Systematic Zoology, and am curator of birds, mammals and fishes in that institution. Two years ago, the coming first day of December, I was loaned, so to speak, by the University to the Governor, Hon. W. R. Stubbs, and to the state in general, with the idea that the University should undertake to manage the fish and game business for the state. For about two years we have been undertaking to do that work. I still belong to the University and hold my position in that institution, and as a curator of mammals, birds and fishes still have charge of those collections, which are arranged in the first, second, and third stories of a museum building specially built and constructed for museum purposes.

The idea of having the fish and game department connected with the University originated with Gov. W. R. Stubbs. He talked practical, business, and scientific administration for everything connected with the state's business. We were urged by the Governor to undertake the work. We had some knowledge of fish and knew something about fish hatcheries, but had no practical knowledge of the management of such an institution. The fish and game protection business managed by a few hundred deputy wardens did not look good to us. It presaged trouble. However, parties interested, including the Governor and University Regents, urged us to undertake the work. We had serious apprehensions about getting mixed up in a business that had caused so much disturbance in various states, and did about

* Not a prepared paper, but taken by the stenographer from a talk where maps and blue prints were used for illustrations.

everything that one could do, without committing suicide, to keep out of it. However, we were forced into it and there was no apparent way of getting out, either by crawling, sliding, or by going up, down or sidewise. After we discovered that we were really hitched to it we began to think and look the matter over. After getting into communication with most of the good fish and game men of the country and possessing ourselves of the best reports and literature upon the subjects directly connected with the work, we began to plan for the future and have been planning and working from that day to this.

The state had a fish hatchery at Pratt, Kan., consisting of eleven ponds including four small cement retaining ponds. There were only seven ponds adapted to raising fish, and they averaged a little over an acre each in size. After looking this equipment over and studying its capacity and possibilities, we began to work on plans for a fish hatchery that would in a measure be more adequate for the possibilities of the fish interests of the state of Kansas.

We visited fish hatcheries and got into communication with fish men all over the country, and with various departments, particularly those at Washington, in regard to fish hatcheries and fish hatchery work. We then began our designs and plans, which we worked upon and changed until the plans you now see outlined on the blue prints and placed on the wall, for your inspection, were finally worked out.

When the Kansas Legislature went into session in January, 1910, it was necessary for us to go before that body and explain what was required for a good and practical fish hatchery for the state of Kansas, with its possibilities for raising good fish, especially food fish. We went before the Ways and Means Committee and presented an outline of the situation, and crude plans for a new and improved hatchery. The legislature, on recommendation of the Ways and Means Committee, finally appropriated for fish hatchery and other purposes about \$80,000 and further ap-

propriated all funds that could be collected for two years to come from hunting licenses, to be used by the Department of Fish and Game under the direction of the University Regents and the Governor. We re-wrote and assembled such laws as seemed good for the state, and had all the old laws repealed, some of which had been on the statute books so long that they were almost forgotten except when lawyers, especially county attorneys, would dig them up to beat or win cases that the game wardens were trying.

It is not easy to frame a law that will apply with equal justice to all parts of such a large and diversified area, but the legislature passed what we think is a good law for a state that has so many varied interests and with a territory 200 by 400 miles in extent.

We presented to the legislature, through its committees, drawings and plans for a hatchery something after the fashion and embracing some of the ideas outlined here in these blue prints. Of course, it was not complete and many changes and most of the details have been worked out since that time. We tried to explain to the legislature that it was necessary to have a new fish hatchery built upon new lines and in accordance with modern ideas; that we did not think it was economy on the part of the state to run a small, inefficient hatchery, or to keep a force of men and a good car to distribute a few fish. We further urged that to be an economic and profitable proposition a fish hatchery should be large and comprehensive enough to supply all the streams of the state with stock fish, and large enough also to supply the ponds that are now in existence and as many more as may be built for several years to come. We immediately got out a bulletin of 36 pages on the subject of ponds and how to build them on farms and ranches. Hundreds of ponds are now being built to raise fish and also to utilize the water for other purposes; one of the chief ideas is to have and raise fish for food.

We immediately got into a controversy with the sportsmen, who wanted nothing but black bass and true game fish, and the farmers, who wanted fish in some quantity.

A careful study of the situation required another bulletin on fish, explaining our plans and ideas to both sportsmen and farmers of the state. In this bulletin we gave some advice as to what particular varieties of fish should be placed in ponds and in streams. The treatment of the subject made it necessary to take into consideration all the streams and ponds in the state of Kansas, the kind of water, etc., because conditions and the supply of fish vary in different parts of the state. The fish living in the Kansas River between the Missouri River and Manhattan are, in the main, different from the fish that live in smaller streams in different parts of the state. We have such fish as buffalo, redhorse, catfish, carp and drumfish in the larger and muddy streams, but no bass, crappie or sunfish.

With plans and ideas of a new hatchery advertised people generally became interested and have asked for so much information that it has made a demand for a bulletin on fish culture adapted to the conditions of Kansas streams and ponds. Bulletin No. 3, on "Pond Fish Culture," will be the next one issued. These bulletins might be called "farmers' bulletins," as they are primarily intended for the people of Kansas and are especially adapted to cover the conditions found in our own state.

This is not a hatchery intended for raising trout. Kansas has no streams that are adapted for trout culture. The hatching and the raising of black bass is a very different proposition. Most persons who have streams or fish ponds clamor for black bass. Both black bass and channel catfish are asked for by nearly every person with a quarter or half-acre pond. The channel catfish will not breed in ponds and the black bass is not adapted to small ponds.

Now, I want to show you a map of the state of Kansas, which state is 400 miles from east to west, and 200 miles from north to south. The fish hatchery is located just west

of the center and in the southern part of the state; it is in Pratt County, and two miles east of the town of Pratt, which is on the Santa Fé and Rock Island railroads.

It was necessary to get a law passed by the legislature to protect fish in public streams, and especially young fish. If the small and young fish are not protected there will not be any old and large fish. If we do not take care of young chickens and pigs we will never have any grown chickens or hogs.

Another snag we struck was the market fishermen. We called them together in different places and at different times and talked to and tried to reason with them. I could talk to them but there was no reason on their part. They wanted a law to suit themselves, otherwise no law at all. In fact, they wanted no law at all. They all fought my proposition for fish protection and regulation, so that it was necessary for me to go to the legislature and present the matter to the House of Representatives and to the Senate at frequent intervals covering a period of over two months; so that when the bill finally came up every man in the legislature knew more or less about fish, and there were twenty men who had become so interested that they wanted to speak all at once. The fish and game warden was allowed to speak several times on the bill in the Senate and also in the House of Representatives, in order to explain further the nature of the law and its especial advantages for both fish and people. A law was finally passed which we think is good for both game and fish in Kansas, and we are undertaking to enforce that law, and I am having a lot of fun, not to mention other things.

To begin with, the fish law provides that a man can fish with a hook and line any time of the year and take any and everything that he catches, provided he uses but one hook on a line. Three or more hooks make what can be used as a grab hook, the use of which was formerly permitted, and men have caught great quantities of fish by that means, especially in winter time, fishing through the

ice in places where fish were bunched up in schools and bedded. By this method many fish were not only taken, but many were snagged and crippled that were not caught.

In the southern part of the state tons of fish were reported to have been taken in one locality by spears and grab hooks, by fishing through the ice; so a law was framed to cut out the grab hook. One hook is enough for sportsmen. The fishermen can use 25 hooks on a trot line. We try to avoid snag hooks and drag hooks, and all kinds of unsportsmanlike schemes to catch fish by unfair means, especially in the winter time.

Another provision is this: One man may fish with but one trot line and may not hang more than 25 hooks on it.

Then the question of nets and traps arose, and that provoked considerable discussion. We recommended that all kinds of traps and nets be made unlawful, except a seine with meshes three inches square. Then the farmers appeared, saying that they had no time to fish with hook and line, and if they did they could not catch anything. They said that they wanted a law that would allow them to catch a mess of fish once in a while. We explained that we would have a law that would allow them to use a seine just as long and just as wide as they wanted it to be, but the meshes must be three inches square. The idea is that you must not catch with a seine a fish that weighs less than three pounds. If a fish weighing less than three pounds is caught it must be put back into the river.

The law requires that a \$50 bond with two sureties be put up by the person who desires to own and use a three-inch mesh seine. We have received several letters from farmers indicating that they had made successful catches of fish. One party of farmers caught about 300 pounds of fish weighing from 3 to 16 pounds each; one member was appointed to write the Department of Fish and Game that they thought the law was a good one, and that they were well pleased with it. The farmers are satisfied, the sportsmen ought to be and the market fishermen have to be, so

that we have the fishing business fairly well regulated by law. However, it is no easy matter to enforce the law against the market fishermen and some others who do not want any kind of a fish law.

On the Kansas River, two years ago, we found in the possession of one fisherman 1,200 small channel catfish. It took seven of those small fish to weigh a pound, and we were informed by one man that he had taken 30,000 channel catfish of that size from the river. There is no use trying to raise fish under such conditions. If fish of the larger varieties are allowed to stay in the streams until they weigh three pounds, the chances are they will spawn once before they are caught. By protecting the young fish we expect to increase the supply of fish considerably in our state in a very few years. With this explanation and understanding the law for the protection and care of fish was passed. With over 300 game wardens who are trying to enforce the laws and who are looking out for the interests of the people, the game and fish business in Kansas is in very good shape at the present time. These wardens serve without pay, except that they get \$10 which is assessed as a part of the costs against each person who is arrested and convicted for violating the law.

At Lawrence, Kan., my home town, it was necessary for us to arrest a dozen men in one day. These men were old friends of mine, who had caught fish for years for me for laboratory use; but they simply would not quit using unlawful nets until they were arrested and made to do it. We arrested the whole bunch, took a wagonload of nets and hauled them through the city to the court house. After a few lessons of this kind even our fishermen friends had a very great deal of respect for the fish laws.

Since the new fish and game laws were passed we have given most of our time to working and studying over plans for a new fish hatchery. We got \$80,000 from the legislature, as much of it to be used in building a fish hatchery as we thought advisable, and in addition, all the money we

could collect in the next two years from the sale of hunters' licenses. A law has been passed requiring licenses to hunt rabbits, and we will receive the money collected for licenses for two years to come, in addition to the appropriation we already have.

These laws do not apply, of course, to private ponds, but only to public waters. A man who builds a pond on his own land holds it as his own private property and can do what he pleases with it; but all the streams, lakes and bits of water fed by streams come under the provisions of the law. Naturally, moreover, men who build ponds usually take the best possible care of their fish and are anxious to learn about fish culture.

These 22 blue prints that you see on the wall will give you some idea of the plans and make-up of the new hatchery that Kansas proposes to build. These eleven ponds [indicating on blue print] four of which are small cement retaining or storage ponds, make up the old hatchery. By condemning and purchasing about 100 acres to the west of the old hatchery, the state now owns over 160 acres of land which stretches along the south side of the river [indicating] for a mile. This ground is just the right elevation for ponds that can be filled from the proposed water supply and yet be drained, dry if need be, into the Ninnescah River, which flows from west to east along the north side of the proposed hatchery. This river flows through a low bottom or valley about a quarter of a mile wide, sufficient to carry all storm and flood waters without overflowing or interfering with the hatchery ponds. The hatchery grounds have a slope from west to east of about 16 feet per mile, sufficient for a good gravity run for the water through the pond system.

The pipe line will bring the water from a distance of one and one-half miles west of the hatchery grounds. The water will be carried through a 21-inch pipe. It will be fed from a 5 or 6 acre lake made by constructing a cement dam 500 feet long across the Ninnescah. In laying this pipe line

no cut will have to be made deeper than one and one-half feet. The Ninnescah River (more properly speaking a creek), which will supply this pipe and the hatchery with water, has its origin in springs about 8 miles west of the hatchery—no large spring, but a great many small ones. Dry weather does not seem to affect this stream. It runs water enough to supply three or four pipe lines such as the one that will feed the hatchery ponds.

The 21-inch pipe carries the water into a receiving pond from which five distinct streams of water will flow by a gravity run through the 100 or more ponds of the hatchery.

In selecting a site for a hatchery to raise bass, crappie, sunfish, and catfish we gave our especial attention to the possibilities of a food supply for both old and young fish. Water that runs 12 to 15 miles (measured as the river runs) through patches of plants, little pools, swampy places, and is finally collected in a seven acre shallow lake, from which it is delivered to the hatchery ponds, must of necessity be pretty well supplied with food material for fish, both young and old.

The Ninnescah River for five miles above the hatchery grounds is well supplied with vegetation, including watercress and various kinds of water plants that grow in good, clear water. This river is also well stocked with small fish, particularly minnows, of which there are great schools. Insect, crustacean and small plant life is also abundant.

We have made something of a study of the food habits of the bass. One thing is sure, they must have a good and plentiful supply of food. One hundred spawning bass in a two-acre pond will devour somewhere (according to experiments) from three to five times their own weight in food each year, and this food is taken alive. It is hard to keep and breed any kind of small fish, such as minnows and crayfish, in ponds stocked with bass. The bass soon eat up the stock supply. About fourteen bushels (measured in water) of tadpoles (of the large green bull frog variety) were placed in one pond. They did good service. The bass would

not eat the tadpoles, but took them as fast as they developed into frogs. About 5,000 yearling goldfish and 50 pairs of large spawners were placed in the same pond. The yearlings were all taken, but most of the old goldfish (weighing from one to two pounds each) escaped. However, all the young goldfish were taken by the young bass of the season. This same pond was supplied with hickory shad, old and young, and river minnows. About 50 pairs of crappie spawners were in the same pond. When drained in the fall there were about 35,000 young bass and crappie. The young bass were feeding upon the young crappie and upon each other, and the old bass were feeding upon both young bass and young crappie, and almost any live thing they could find. The goldfish were all gone except about half of the old spawners. There were a few tadpoles left that had not changed into frogs and a few small minnows, but none of the 500 goldfish that had been thrown in the pond about two weeks before. These bass had learned to come to certain places to be fed and would take goldfish as fast as they were thrown in.

One fish, taken from this pond with a hook baited with a goldfish, had five goldfish in its stomach. This fish weighed about two pounds and the total length of the five goldfish found in its stomach was greater than the length of the bass itself; yet it bit at the sixth goldfish. There were 100 bass in that two-acre pond and if each one took five goldfish for a meal the supply of 500 would be devoured at one meal. Last fall, while moving bass from one pond to another, we found that a bass weighing $2\frac{3}{4}$ pounds had caught a bass weighing 2 pounds and was trying to swallow it, the smaller fish being head and shoulders in the mouth and throat of the larger. It took some work to separate them, then both swam away. It is not an uncommon thing to find fingerlings and yearlings that have choked to death trying to swallow their brethren.

The number of bass that can be raised in a body of water depends largely upon the amount of food it is possible to

furnish them. If food is not plentiful the little fellows only an inch and a half or two inches long become cannibals at once. It is not an unusual thing to find a young bass swimming about with the tail of another young bass sticking out of its mouth.

We have received many letters from people who want to know how to keep the moss out of their ponds. We consider a good growth of moss of great advantage to fish ponds. It furnishes an abundance of food either directly or indirectly for most varieties of fish, and is especially valuable for the protection of young fish.

We will not have time, and the expense would be too great, to seine and sort fish in a hundred ponds. We propose to leave the fish, old and young, in the ponds until they are drained, which for the most part will be done during the fall months. The ponds in this new hatchery can be connected one with another by water supply pipes and by open cement ways 29 inches wide. Food fish for both large and small bass can be raised in adjoining ponds. The ponds can be separated by flash-board and wire screen gates. This arrangement will permit of many things; for instance, the young bass can pass through wire screen gates into ponds stocked with minnows and goldfish and this will give the young bass a chance to feed on the young of other fish. This food pond will be in readiness for the young bass as soon as they are able to make their way into it. This is one of the methods that we propose to use in the feeding of young bass. Ponds with yearling goldfish and other fish will be in readiness to supply the spawning bass with food.

The black bass seems to do well in many Kansas streams. They have been there since the earliest settlers made homes in the state, over 50 years ago. We hope to keep the streams stocked with these fish. In Kansas every sportsman wants to fish for black bass. My favorite scale fish for ponds, however, is the giant crappie. These fish do well in ponds and are very prolific. In planning the hatchery we looked to an

arrangement that would not only produce bass, but giant crappie.

Another fish for which there is a considerable demand is common bullhead catfish; we will raise them. We have been experimenting with them and find that they can be fed on corn, wheat, meat, potatoes, bread and such material. They grow in three or four years to over two pounds in weight. We exhibited a bunch of them at the state fair at Topeka, and most of the farmers who saw them said that those were the fish they wanted. We will supply them with the best species of catfish. They are especially desirable because of the great variety of food they consume and also on account of their hardiness and their ability to live in a small amount of water during dry spells. We have fed them on corn bread, graham bread, potatoes, bran, cornmeal cakes; in fact, they will eat almost anything. A thousand of them will come up at the same time near the surface of a pond to feed in a place where they have been accustomed to be fed. It is a good idea to give them some meat and liver; but the main part of the food that we gave them was vegetable matter, because ordinarily it is cheaper and easier to handle than animal food.

Considering all the things that we hope to accomplish, and considering the fact that Kansas has 80,000 square miles of territory, and taking into account the number of fish that one acre will produce, our hatchery of 100 acres of pond water will not be a large hatchery for a state like Kansas.

Here [indicating on map] you have a bird's-eye view of the number and the arrangement of the ponds of the hatchery. There are 83 ponds in this section in the proposed new hatchery, and from 12 to 20 more to be built later on. There are 11 ponds in the old hatchery, but four of these are small cement ponds used for handling fish. The contract will be let in a few days for the building of these 83 ponds.* The

* This contract was let to James A. Green & Co., Inc., of Chicago, November 21, 1911, the work to be completed by August 1, 1912.

ponds and water system of the old hatchery will be rebuilt separate from the contract for the new hatchery.

We will leave the old hatchery as it is for the present, in order to hold over fish for the proper stocking of the new ponds. The old part will not be rebuilt until the new part is finished and stocked. The ponds in the new hatchery will vary in size and shape, but will average about one acre each. When normally full no pond will have less than six feet of water in the deepest part. The water will grow shallower toward the perimeter. This arrangement will furnish good feeding grounds for the young fish in the grass, weeds and moss growing near the shore line. The embankments will be made of earth. We have had no success raising fish in a pond with cement walls instead of earth embankments. There is not sufficient shallow water near the shore line for the young fish to feed in; and not a sufficient growth of vegetation to furnish and support fish food in such a pond. The cement pond seems to be a failure so far as raising fish is concerned.

Other ponds with steep banks and deep water near the banks have not proved satisfactory, yielding but few young fish. The ponds of about an acre in size with a considerable amount of perimeter and shallow water with vegetation growing in them have proved most satisfactory as fish producers. To illustrate: Take this pond [indicating on the map] in the old hatchery. We have a pond here of a little less than an acre, with shore line and vegetation as previously described. A year ago last spring we stocked it with about 88 giant crappie or strawberry bass. We left them in the pond the entire year. They did not cost anything, so far as any special labor or care was concerned, as they were not fed, except that the pond was stocked with goldfish. We paid little or no attention to them except to keep the turtles out. They required only seining and sorting. We drained the pond last spring and counted the fish, as it was an experiment. We took out 14,600 crappie nearly a year old, and found the old fish in good condition. The pond was a

solid mass of vegetation in the fall, which somewhat disappeared during the winter. When we drained the pond in the spring it was necessary to pile up the moss and water plants in places with forks; this was done when the water was low enough to wade in with rubber hip boots. The water was about two feet in depth when we seined out the large fish. We then let the water run out slowly and picked out the little fish with minnow seines and hand nets.

This one pond containing two acres of water shown on the blue print was overstocked. We had 200 bass in that pond and about 100 crappie, and an undetermined number of sunfish. We did not have the success with it that we hoped for. When we drained the pond, we got, if I remember correctly, about 12,000 bass and about 8,000 crappie, about 20,000 fish. However, unknown to me, there were about 400 yearling bass in that pond that had not been taken out the year before. Now, if there is anything that is destructive in a breeding pond it is yearling bass. There were, also unknown to me, about 600 yearling crappie in the same pond; so we had 400 yearling bass, and about 600 yearling crappie to contend with; and that would evidently reduce the number of young fish.

Yet I would rather take the number of young fish that we secured at almost no cost of raising than a larger number that could be raised at the expense of keeping the pond clean and the added expense of caring for them all summer, seining them and sorting them. We do not intend to seine or sort fish if we can get along without it. We want to produce the proper conditions for the breeding and spawning of each kind of fish that we raise, but we do not expect to handle them until fall or spring, when we drain the ponds.

We prefer to drain bass ponds in the fall and crappie ponds in the spring. We think it is a great advantage to put crappie in with the bass and breed them together in every pond. This year we had crappie in with the bass; the bass ate a considerable number of crappie, but that made no difference as we had to feed the bass on something. When

we drain the ponds we find about as many young crappie as young bass, notwithstanding the fact that both young and old bass feed on the young crappie. We have never had enough goldfish, although we raised 100,000 this year, to supply the bass ponds. We have never been able to catch minnows enough in our part of the country to amount to much as bass food. Three or four men working all day would, as a rule, only get a few thousand; and again minnows are hard to handle and keep alive when they have to be transported any distance.

Not being able to catch minnows in any quantity, we expect to try to raise them in ponds for fish food; we also expect to run them into the hatchery from the river through the conduit pipe. By the use of wire screens we expect to pass the minnows into certain breeding ponds and allow the young fish to pass into certain minnow ponds. We expect to raise goldfish in great numbers for fish food, and will also raise carp for the same purpose. Gizzard shad also have done well as a food for other fish. The shad have apparently done us good service when bred in the same ponds with the bass. At least, when we drained the pond we found nothing but old shad in with the bass, although in the summer season we noticed thousands of young shad swimming in schools; they had all apparently been devoured before we drained the ponds.

Thus we have been experimenting with a few ponds with more or less success. However, the successes and failures we have had have given us ideas for the founding and the building of the new and improved hatchery. We have not been guided alone by our own experience, but have tried to profit by that of every other fish culturist in the country.

The Kansas State Fish Hatchery, as planned, will be a quarter of a mile wide and a mile long. The water from the supply lake, one and one-half miles west, will be brought through a 21-inch pipe and delivered into Pond No. 1 [indicating on map], which will act as a re-

ceiving pond, and from this pond five streams of water will start and connect with and flow through all the other ponds. The ponds are all connected, as stated before, by cement runways 29 inches wide and with supply and drain pipes. The walls of the cement structures conform to the contour of the embankments, but are about a foot higher on the sides of the earth embankments than the banks themselves. There are grooves in the walls of these cement structures for receiving the stop-boards and the wire screens.

There will be about a dozen small houses located at different places on the grounds, for storing tools, material and the wire screens not in use. There will be three or four houses for superintendents and regular employees. We also intend to install a telephone system so that the main office can communicate with a dozen or more stations on different parts of the grounds. There will be about four miles of roadways, wide enough for automobiles, and several miles of roadway embankments not so wide, but wide enough for smaller vehicles and for "foot passengers." All the roadways are over the embankments and run for the most part the long way of the hatchery grounds, east and west, but the connecting roads run north and south. The cement waterways connecting the ponds will be covered with cement slabs, strong enough to support the vehicles that pass over them.

The ground that is to be converted into ponds is very irregular, full of ups and downs. This is very fortunate for pond construction, as nearly every pond in the system has its centre near a low place. This accounts for the irregular shape of the ponds. The amount of earth to be removed in forming the pond basin is in most cases just what is needed for the embankments for that particular pond. There will be very few long hauls. This will make very economical construction compared with work on a level piece of ground where the ponds would have to be excavated or dirt hauled a longer distance to build the embankments.

Many of these blue prints are full of details, intended especially for the engineers and contractors. I do not care to bother you with the details of construction. I am trying to give you only a general idea of what the proposed hatchery will be.

Take Pond 52, for instance. The water can be cut off from it without interfering with any other pond. This Pond 52 can also be drained without interfering with the water supply or drainage of any other pond. This is the system arranged for all the ponds.

Each pond in the system can be either filled or drained in from 24 to 36 hours. We find it to be of great advantage to be able to fill or drain a pond in a comparatively short period of time; however, the ponds may be filled and drained slowly, by turning the water on or off, as the occasion may demand. The smallest drain pipe used is eight inches in diameter. The river into which the water is drained is a few feet below the level of the bottom of the ponds, which fact makes a good drainage system possible.

These blue prints showing so much detail of inlets, outlets and valves, I will not undertake to explain unless you want especially to know about them. It would be rather out of place at this time in this rambling account of the proposed new hatchery.

We have been connected with this hatchery work for about two years. We have always felt that Governor Stubbs and others concerned pushed or forced us into it. We were pretty well satisfied with our University work before we undertook this job. However, after we discovered that we were in the business we tried to "get busy," and have done the best we could. We began at once to study the hatchery business and began to plan for a hatchery adapted to the conditions of our own state. We talked fish hatchery to everyone and talked it all the time. When the time came we presented the matter to the legislature and tried to explain what we thought Kansas ought to have. We stood for a good hatchery, one that we thought would

be a benefit to all the people of Kansas. We tried to explain that after such a hatchery had once been built and equipped it would not cost much more to operate and maintain it than it would to run a much inferior one. We tried to stand for the right kind of economy, the kind that would bring practical results. We took the ground that the streams of Kansas could be stocked from the hatchery and made valuable as fish producers, that pond fish culture could be made valuable for the farmers, that farmers should be encouraged to build ponds, that each farmer who was enterprising enough to build a pond should receive fish in the shortest possible time from the state fish hatchery, and that we proposed to take them to him free of cost. We expect to deliver them from the state fish car when possible, otherwise send them by express in ten-gallon milk cans, with an attendant, to the farmers' nearest station.

Another point that we tried to explain was that instead of taking the farmer little fish, fry, fingerlings, etc., we would take him fish two years old, fish old and large enough to spawn. We expect to keep the fish in the hatchery until they are large enough to spawn. If we do not have ponds and water enough to do this we will get more land and build more ponds. When a farmer completes a pond and wants fish, he wants them right away. We want to be ready to supply him with from ten to fifty pairs of spawners, in proportion to the size of his pond. Such a delivery of good, large, plump fish will please the farmer. He is excited about the fish business and has been ever since he began to build his pond, and wants to get to work right away. We want to help him just at the right time and in the right way.

We have tried delivering little fish and big fish to farmers with ponds. Little fish make them look serious and ask a lot of questions. Big fish make them smile and look happy. The delivery of fish two or three years old puts them in the fish business immediately, and they are quick to see that it will be only a short time until they can expect to

eat fried fish from their own ponds, and plenty of them, which makes them feel good.

DISCUSSION

MR. D. B. FEARING, Newport, R. I.: You will be Governor of the state of Kansas in two years. (Applause.)

PROFESSOR DYCHE: Thank you. I will now be pleased to have you feel very free to offer any and all kinds of criticism relative to the ideas presented and plans that I have been showing you. I have been seeking help from every direction and am still seeking more help. We want to build a good fish hatchery for Kansas, and I want to make it up to date, if possible, being guided and directed by the ideas of men who have been working and thinking along these lines.

MR. MEEHAN: I want to ask what you fed the crappie?

PROFESSOR DYCHE: Nothing at all; but we try to provide conditions that will furnish natural food supplies not only for crappie but for other fish. We are not going to feed fish—that is slow business, it seems to me, for most of the kind of fish that we are going to raise. We have fed corn, wheat and bread successfully to catfish and carp. Last year we fed a lot of carp, channel catfish and bullheads during the fall, winter and early spring, and brought them out in fine shape on corn chop and bread. During the present summer we have fed a few thousand catfish (bullheads and channel cats), together with goldfish and bluegills, all in the same stock ponds. Some chopped meat and liver was added to the bill of fare. These fish learned to eat almost anything in the way of meats, vegetables and grains. They seemed especially fond of table scraps. The fish described are in stock ponds and are being held to stock the new ponds when finished and in condition for fish.

MR. L. A. GESERICH, St. Louis, Mo.: How are those lakes constructed so far as the control of the water is concerned—how do you drain them—by valves?

PROFESSOR DYCHE: By valves.

MR. GESERICH: Each one is connected with a valve?

PROFESSOR DYCHE: Yes.

MR. GESERICH: You can drain them all if you want to?

PROFESSOR DYCHE: Drain them all or drain one independent of any of the others.

MR. S. G. WORTH, Mammoth Spring, Ark.: What style of pipe is used in the drainage?

PROFESSOR DYCHE: We will use about 26,000 feet of vitrified clay pipe; the sizes will range from 8 to 21 inches; the joints will be sealed with Portland cement under the direction of a resident engineer.

MR. WORTH: The reason I asked that question is that it has become a conviction in the Bureau of Fisheries, I believe, among the superintendents, that terra cotta pipe is a very bad thing.

PROFESSOR DYCHE: We expect to use vitrified clay pipe and cement the joints, using methods that have proved satisfactory in other parts of our state in connection with water-works and sewer systems.

MR. WORTH: I hesitatingly make any suggestions to the gentleman because after many years' experience in this class of work I must say that I am highly delighted with what I have heard, for it seems to me most practical, but I just wanted to call attention to that one thing of terra cotta joints made with cement mortar.

PROFESSOR DYCHE: The system that we will use has been operated successfully in several parts of our state.

MR. WORTH: I would like to make my point clear. If there is a leak in the underground system of drainage beneath the bottoms of the ponds the crayfish will work through the opening up into the pond bottom and make an underground leak in the pond.

PROFESSOR DYCHE: I do not see where any crayfish could get in between the pipes. They could not do much in an eight-inch pipe if they went in with the water except to get out again. Crayfish could not interfere with the flow of the water in our smallest pipes, which are eight inches in diameter. The system is the same as the water and sewer systems of the state. Prof. W. C. Hoad, engineer at the University, who looks after the sewer and water systems of the state, told me when I brought up the subject of crayfish that there would not be a joint in the entire system of piping that would admit of a crayfish entering. He said that the joints would be absolutely proof against such marauders.

MR. WORTH: If the joints are good it will be all right.

PROFESSOR DYCHE: The engineer is to see every particle of this work done. Every earth embankment is to be built in a certain way; they are to be kept level and be built in even layers; the engineer will be on the ground to see that every inch of work is properly done. The specifications call for a great number of specially constructed and detailed things. The engineer will see that the plans and specifications are followed in construction. This engineer, Professor Hoad, is one of the most competent and experienced men in the country and has charge of all the sewer and water systems of the state of Kansas. He has had his men working for about six months preparing these drawings for me. We always got together on any part of the work and studied it until we thought we knew what we wanted. We availed ourselves of all information we could command before we acted. After we decided upon any plan or system or way, Professor Hoad and his assistants worked it out with great care from an engineer's point of view.

MR. GESERICH: How many ponds have you?

PROFESSOR DYCHE: There are 83 in the new hatchery, 11 in the old, and about 15 to be built after the new hatchery is finished.

MR. GESERICH: Where do they drain?

PROFESSOR DYCHE: Into the Ninescaw River, which flows parallel with and just north of the hatchery grounds; there are several places where the drainage pipes empty into the river.

MR. GESERICH: Suppose you wanted to drain Pond No. 32 for example?

PROFESSOR DYCHE: Pond No. 32 is on the south side of the hatchery and one of the farthest from the river. It will be drained through the pipe that has been laid under its north bank. The water will enter the drain pipe at the northeast corner. This same drain pipe you see [indicating on map] leads almost straight north to the river. Ponds Nos. 31, 30, 41, 39, 40 and 42 you will notice discharge their water into this same drain pipe; there are several drain pipes leading to the river, making a number of almost separate systems.

MR. GESERICH: In other words, you have runways for each and every pond?

PROFESSOR DYCHE: Yes. I have another blue print; one that shows every drain pipe and runway. There are usually 8, 10 or 12 ponds hitched to any one system or runway; but these eight-inch pipes lead to and connect with larger pipes that carry the water to the river.

DR. TARLETON H. BEAN, Albany, N. Y.: What provision do you make against the crayfish working in those embankments?

PROFESSOR DYCHE: There is no provision for that. Crayfish have never bothered our banks. A bushel or more of crayfish was once dumped into one of the bass ponds and they soon disappeared. When we drain the ponds we do not find any of them.

DR. BEAN: But how are you going to prevent crayfish from boring through the embankment from the outside?

PROFESSOR DYCHE: In one sense of the word there is no outside to the embankments surrounding such a system of ponds. We have one embankment running right up against the river in the old hatchery and we have never been troubled with crayfish boring in it. I do not know of a single case. This river is well stocked with channel catfish and black bass. These fish may keep the crayfish cleaned up; however, crayfish have at times in the past been purposely placed in the river.

DR. BEAN: Then there are no crayfish left. One of our problems is to prevent them from making trouble. Have you much frost there?

PROFESSOR DYCHE: Very little. The vitrified clay pipes will be placed from three to five feet underground.

MR. W. T. THOMPSON, Fairport, Iowa: If anyone were to ask me for a definition of the word enthusiast, I would simply point him to Professor Dyche and say: "There is your enthusiast personified." I do not believe Professor Dyche's applications will be limited to the state of Kansas if he furnishes the farmers fish weighing three pounds. I remember hearing of one member of this commonwealth (Missouri) sending in an application to the government for catfish. He was notified the fish would arrive by car at a certain time. He went to the car, the captain passed him out several cans of fish, he took off one of the covers, looked inside and saw that the fish were only about three or four inches long. Turning his nose up in disgust he said as he walked

away: "Oh, hell, I thought you were going to give me some big enough to eat."

MR. GEORGE H. GRAHAM, Springfield, Mass.: I cannot help having a kindly feeling toward Professor Dyche. I believe he is on the right track, and if every commissioner in the United States were on the same track that he is, we would have something done. He is trying to popularize the work, and he is going at it in the right way.

In the first place he has gone to the legislature with a concrete proposition; he has told them what he wants to do, and is putting it up to them as a business proposition. It is not any fad, such as we have in a good many states. It is a business proposition; he got all the money he wanted. I believe that any commissioner can go to the legislature, and if he can convince the legislature that he is going to do something for the benefit of all the people, he can get what he wants. We in the eastern or the central part of the country would not take up the kinds of fish that he is handling; but he has taken up the fish that they can raise in Kansas, and he is getting the people interested.

In the eastern part of the country I believe we can get a great many farmers who have small streams interested in raising brook trout. I had an article printed in a newspaper to that effect and immediately six people came to me and asked if I could give them any literature to aid in constructing ponds in which to raise brook trout. They had plenty of good water, but did not know how to use it. Well, I wrote around to some of the different commissions and to the Bureau of Fisheries, and to Mr. Townsend in New York, and tried to get some information. All I got did not amount to very much. There does not seem to be anything printed that is very good to send to a farmer who is green at the business, which will show him how to go to work to raise these fish. My idea is that we should endeavor to make the work more popular. You get a hundred farmers in a county interested in raising fish, having trout ponds, etc., and they will help you in the legislature, and in many ways in the work, and that is just what Professor Dyche is doing out in Kansas. I believe the more people we can get interested in fish culture and the propagation of fish and game at the same time, the more popular will become the work of the fish and game commission, and when you can make the work very popular, you will get all the financial support from the state and national government that you want. Professor Dyche is on the right track, and I believe we have all learned a good deal today from what he has had to say.

MR. MEEHAN: I think we can agree there, for in Pennsylvania, when it was announced that we would raise catfish and other commercial fishes they increased our appropriation from \$35,000 to \$205,000.

MR. FEARING: As a fish commissioner of Rhode Island I want to thank Professor Dyche from the bottom of my heart. He does not know what it is to go before a legislature that thinks there is "a nigger in the woodpile" all the time. Mr. Graham stated that any legislature would do anything if it was put before them as a business proposition.

We have tried very hard to convince our legislature that lobster culture is a business proposition, but we cannot make them do anything and we get mighty discouraged sometimes. But what Professor Dyche has done puts new life into us; and if we all looked at things the way he does, perhaps we would all do better work.

MR. GRAHAM: I think the legislature of Kansas has absolute confidence in the state commission.

MR. FEARING: Our commission is curious, in that it is working for the love of the cause and without pay.

DR. S. P. BARTLETT, Quincy, Ill.: Professor Dyche has overcome difficulties that seem insurmountable. I have been before the legislature 35 years endeavoring to accomplish similar objects, and fully comprehend the difficulty of the work.

I cannot say anything about the workings of those ponds, but the idea is mainly the rescue of the fish. I like his plans for the distribution of the different varieties, but I could not be loyal to the interests I have represented if I did not object to his cutting out carp.

PROFESSOR DYCHE: I am a great friend of the carp. I will talk carp to you for an hour if you wish.

MR. MEEHAN: That subject is tabooed.

MR. W. O. BUCK, Neosho, Mo.: I wish Professor Dyche would explain some details, especially in regard to the openings. The problem of controlling the outlet of the ponds is a difficult one for me, and I imagine it is the same at most stations. I wish Professor Dyche would explain what arrangements he has for getting absolute control of the fish.

PROFESSOR DYCHE: You mean for getting water from the pond to the river?

MR. BUCK: No, holding the water, preventing leaks and holding it at just the height you wish. How about leaks?

PROFESSOR DYCHE: Our engineer, Prof. W. C. Hoad, of the Kansas University, will use practically the same system of cement runways, pipes and valves that he has installed in other places in the state in connection with water works and sewer systems. Between any two ponds he constructs a cement runway, 29 inches wide, built up on both sides; and this cement structure runs down into the water on both sides and the wall on the sides of the embankment is one foot higher than the earth embankment. The flash-boards are put in so as to regulate the height of the water in the pond. Wire screens of different sized mesh will be used to regulate the fish. The stop-boards fit so well that there is practically no leak. In a gravity run such as we have there is no great pressure anywhere and consequently no leaks except where poor workmanship or some accident might cause it.

MR. BUCK: The flash-boards are set horizontally, running in slots in the concrete, are they?

PROFESSOR DYCHE: Yes. The engineer has such flash- or stop-boards in good working order in other localities. I might say that the engi-

neer, Professor Hoad, and myself visited Mr. Buck at Neosho, Mo., and examined the government hatchery that he is directing.

MR. WORTH: I will venture the assertion that Professor Dyche has the largest and most comprehensive pond system in the United States and perhaps in the world. I certainly admire it.

PROFESSOR DYCHE: There is one part of the station planned as you see on this map (indicating) that will not be finished at present. It will be built after the present station is completed. I refer to the remodeling of certain ponds and the adding of a dozen or twenty more which have already been planned. We will build 83 new ponds now and after that there will be enough more to build to make 107 ponds which will cover about the same number of acres of water.

MR. G. W. N. BROWN, Homer, Minn.: Don't you think it better and more economical to make your ponds more regular in shape, so that the drain pipe lines will be straighter?

PROFESSOR DYCHE: That is a good question. This ground is very peculiar. There are bumps and hollows, ups and downs; and the ponds really located themselves in natural depressions; it will only be necessary to remove enough dirt to give the pond basin proper shape and to make the embankments. Therefore they are by nature irregular in shape and size, but this is immaterial for fish-cultural purposes. It will make construction economical, because we take advantage of the natural contour of the ground.

MR. BROWN: The topography of the ground shapes the ponds?

PROFESSOR DYCHE: Yes.

MR. BUCK: You have to dig under each of your embankments to make your outlet pipes?

PROFESSOR DYCHE: The pipes will be laid before the embankments are built and will be under the dikes. The work will be done in such a way under the direction of the resident engineer that one part will not interfere with another, but the pipe lines will go in first and the earth will be filled in over them.

MR. BUCK: If there should be occasion to repair them you would have to dig pretty deep, would you not?

PROFESSOR DYCHE: Yes, but the pipes will be directly under the embankments, so that they can be easily reached; we expect to put in a system that will not need to be dug up, except perhaps in rare instances.

MR. BUCK: After you get your embankments built they will be some ten feet under ground, will they not?

PROFESSOR DYCHE: That is true; but the pipes will be accessible if it is ever necessary to dig any of them up.

MR. THOMPSON: Professor Dyche has told us of a number of pamphlets he has written which have been issued by the state. I suggest that he write just one more, on the subject of: "How I Did It." I think it would be a good lesson to all the members, and more especially the state commissions, to learn how he manages to have the state of Kansas build one large hatchery instead of half a dozen little one-

horse affairs, scattering their money all over, entailing considerable unnecessary expense in construction besides an enormous annual outlay for propagation and repairs at all these different points, instead of centralizing it, as they have done, at one point. I think this is one of the most sensible things the Kansas Legislature has done, outside perhaps of providing for Professor Dyche as Fish Commissioner.

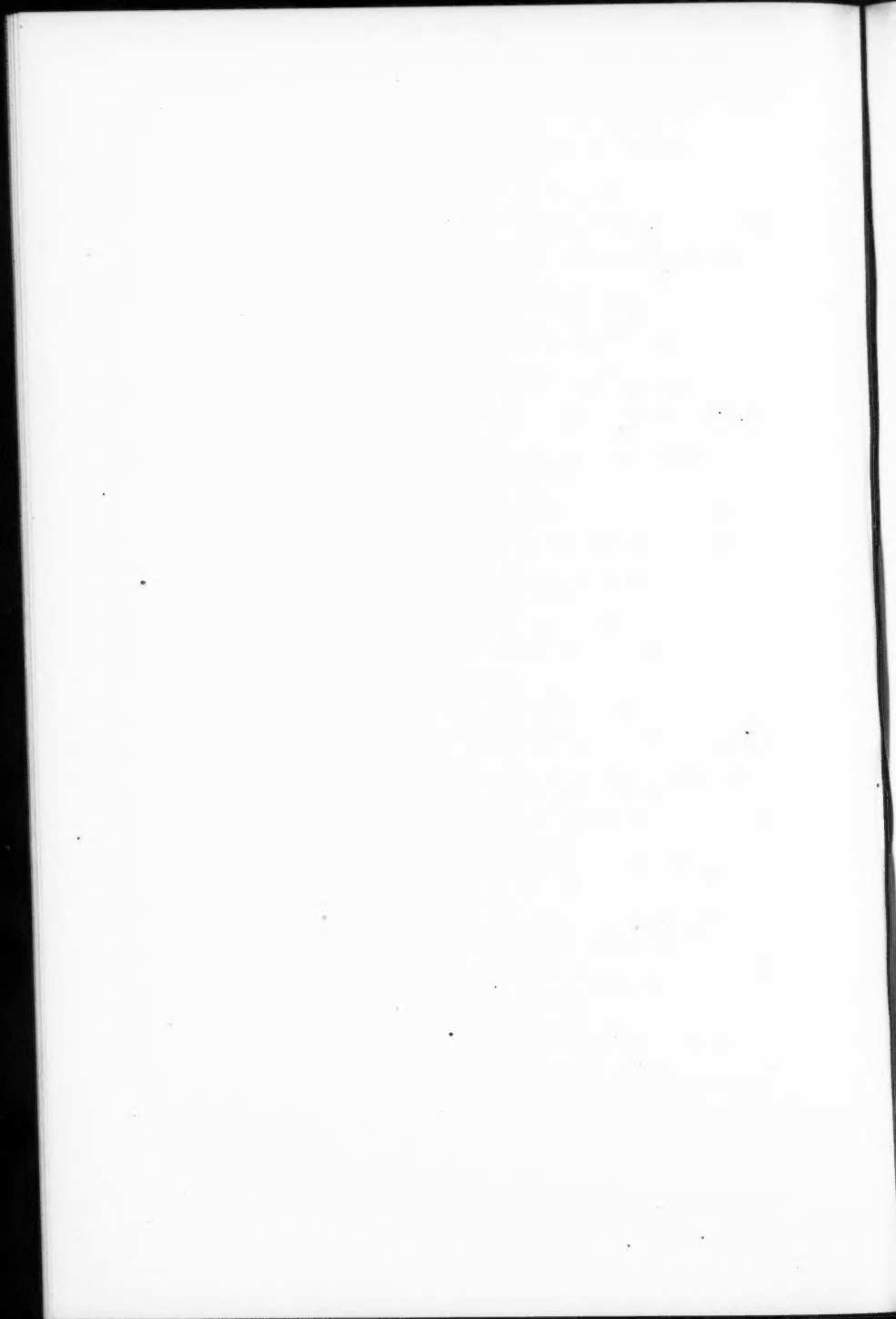
In many of the smaller states of the East, not referring, however, to the baby state—Rhode Island—so ably represented here, but in New Hampshire, for instance, they had about seven hatcheries at one time. Their appropriation was small and they dribbled it around so that there was practically nothing for the operation of each station. They could accomplish but little under such a handicap. Eventually the commissioners secured the approval of the legislature to close a number of the hatcheries. With the same appropriation, they were then enabled to secure a much larger output. I think Vermont, and probably some of the other states, have had a similar experience. State hatcheries are recognized as being a political plum. Each legislator thinks if he can bring home a fish hatchery for his section he has fulfilled his duty toward his locality and his constituents.

MR. R. K. ROBINSON, White Sulphur Springs, W. Va.: I would like to ask Professor Dyche if he considers an eight-inch pipe sufficiently large for drawing down the ponds when he desires to draw them down rather quickly?

PROFESSOR DYCHE: The drain pipes will connect with the deepest part of each pond and any pond can be drained in from 24 to 36 hours.

MR. ROBINSON: Do you consider that quick enough?

PROFESSOR DYCHE: Yes. As a rule we do not care to run the water out in such a short time, particularly if the pond has a good growth of vegetation for the young fish to hide in. The fish must be looked after. I have not seen many ponds at other hatcheries that could be drained very quickly. All the water can be drained from these ponds. Most of them have two supply pipes and can be filled much quicker than emptied.



NOTES ON THE FISH OF THE CUMBERLAND RIVER

By J. F. BOEPPLE

While examining the Cumberland River during the summers of 1910 and 1911, from its headwaters to its mouth, for information as to the mussel beds, I devoted some time to observations relative to fish:

Among the largest yellow catfish I saw caught was one weighing 59 pounds. The largest buffalo weighed 16 pounds, while the largest haul I saw made in the trap baskets was 58 pounds. A very reliable fisherman claims he raised some baskets of 100 pounds, and all channel cat, which they call "fiddlers" there, and the largest of which weighed 2 pounds. Drumfish, for which they use trot lines, were also conspicuous in the catch.

I found a great many people fishing with dynamite, and one of the first things I heard was complaint on the part of the fishermen against this method of fishing. A farmer at whose house I stopped told me that the week previous dynamite had been used that resulted in killing a catfish of 64 pounds. He gave me to understand that he knew these people, but dared not say anything for fear of damage to his property.

While working up the river bottom for mussels, I found places where there was no life of any kind—no insects or worms, and upon inquiring among the fishermen learned that dynamiting had been done. It appears that not only the fish are killed, but all life in these eddies is destroyed, and I was informed by the fishermen that for a long time after dynamiting no fish are caught.

I was working three months on a portion of the river which was locked and dammed, some places for one year, other places for three years, and some even for seven years. The opinion of all fishermen that I talked with was that

fishing was much better since the system of lock and dam had been placed.

Means should be found to stop the dynamiting of fish. The damage is too great.

SOME OBSERVATIONS ON SUNFISH CULTURE

By J. J. STRANAHAN

The bluegill sunfish of the north, erroneously known as the bream in the south, is, in the opinion of the writer, the fish par excellence for pond culture, particularly for the pond of the farmer or planter. In fact, in the light of recent developments, it might be predicted with a reasonable assurance of fulfillment, that even the urban resident with a fish pond in his door yard co-extensive with his dining-room may have a mess of fresh fish of his own raising, now and then, at the same time lending beauty and interest to his surroundings with less expense than would be incurred in keeping up the same area in lawn—water, fertilizer and muscle considered. I believe that I am not very far ahead of my time in respect to reducing the high cost of living when I say that for a given amount of protein or real food value fish flesh is ahead of fowl or mammal, everything considered, including, of course, cost of production.

The sunfish, *Lepomis pallidus*, lends himself to domestication most graciously. In fact he seems and acts as if he wanted to be civilized whether we like it or not. He is comparatively free from disease, makes rapid growth when given a little care and proper food and, best of all, is of most excellent flavor and quality with only just bones enough to make us relish the two sides of delicious food that his anatomy carries with a minimum of waste. His rapid growth in popularity, taxing the fish-cultural stations to their utmost limit, attests the truth of this seemingly rather enthusiastic statement.

It has for years been considered settled that the sunfish is not cannibalistic or predaceous on its kind even to a small degree. This is a mistake, especially as applied to the young of the species. They will eat their little brothers with a relish that would indicate a highball before breakfast.

The spawning operations of this species in the southern states begin during the early part of May and continue until the latter part of September, this long period due, probably, to the fact that individual females develop their ova at different times, the males seeming always ready. It seems probable that the older and larger females spawn earlier than the smaller and younger ones, and it is apparently established that a single male will occupy the same bed continuously for weeks and even months, accommodating several females during the time.

The writer took up experimental work with the sunfish, in 1909, too late to accomplish much, having been engaged earlier in the season in the study of the speckled catfish (*Ameiurus nebulosus*), which is generally called the marbled catfish in the north, where it is clouded or marbled. It was soon discovered that the late-hatched individual sunfish of the year before were preying on the young recently hatched. All of these yearlings, and there were but few of them in each pond, were immediately removed and close watch kept on the larger ones of the current year's hatch. It was then discovered that these were about as destructive as the yearlings. At least they were watching for and devouring these of the late hatch, as very reasonably was to be expected, for they were about a quarter of an inch long and no larger than most of the animalculæ on which the larger fish were feeding when they could find them.

Many experiments had been made at this station in feeding the fry and adults of the sunfish with corn mush, and with mush made with fine middlings and ground liver in many combinations. The results were always negative. The fish would take these foods for a time, say a few days, and then reject them entirely. At the opening of this season the writer was looking about for some food that might offer possibilities, when finally there was received a sample of so-called "Prepared Fish Food" from a firm at the stockyards in Chicago. It was a fine dry meal of yellowish brown color and, judged by appearances, made from fresh

meat scrap. This sample was tried and a larger one requested and tried and finally a sack of 100 pounds was ordered. The food was tried out on fry and adults of the various species on the grounds with most gratifying results, even the small-mouth black bass, rock bass, catfish, etc., all taking it with much relish and thriving on it so far as we know up to the time of writing. Of course our greatest success was with the fry of the sunfish for the reason that we had them in greater numbers and because we were bending every effort to make a success of their production on a large scale.

This food is about like fine corn meal and about as free from lumps. It mixes readily with water and after being so mixed sinks slowly to the bottom of the ponds, thus giving the fry time to collect it. We have tried two sacks of a coarser grade, about like grits, which is probably better for the fingerlings, but it is not so desirable for the fry and does not form into a tenacious dough for feeding adults as well as the finer grade.

Our mode of feeding with this prepared food is to put a pint or two into a wide shallow pail or pan, adding a pint of water on one side and mixing in enough feed to make a thin gruel. This we take into the hollow of the hand formed into a cup and cast it over the surface of the water much in the manner that a farmer would sow grain, taking two or three steps between each cast so as to have them lap a little, thus making an even distribution and preventing waste. More water is added to the mixture every few rods, and the aim is to get the food to the fish as soon as possible after the water is added in order to avoid dissolving the albuminoids, which must constitute a considerable portion of the food constituents of the material.

We began feeding twice a day, morning and evening, but later decided that this was not enough and added a noon-day ration with the small fish and fry, especially those in the fry ponds, and I am now of the opinion that where the best results are desired the feeding should be resorted to

four or five times a day, using no more feed but giving it a better distribution and the little fish a better chance to keep themselves well filled.

We have experimented with syringes and spray pumps, but with negative results. The main objection to them is that the feed has to stay too long in the water and it thus loses much of its food value. We have also tried casting the dry meal on the water and when the wind is favorable and light this is not a bad method, for the food sinks slower and gives the fry a longer time to secure it. But if there is much wind, especially if it is freaky, this plan does not work so well for reasons which will be obvious to the reader.

By the use of this food and the system by which it is being administered, the output of this station in sunfish for the first three months of the fiscal year has trebled that of any previous whole year. What the final results will be can only be guessed at, but it looks most encouraging at this writing.

These rapidly grown fish, almost large enough for the skillet when three months old, are not, as some might suppose, tender and hard to handle. They are strong, vigorous and stand shipment during July and August of this record-breaking year with practically no loss, calling forth favorable comment wherever they have been sent. That this mode of feeding is a complete success with the sunfish there can be no doubt, but "what about the other species?" may be asked.

The season was too far advanced for any extended experiments with the black bass, rock bass or catfishes, but what little could be done gives us great encouragement and we predict that it will be just as successful when worked out with them as it has been with the sunfish. Fortunately we had one brood of late-hatched large-mouth bass on which we could do a little experimenting and later we found a very small brood which had been abandoned by the parent fish. These we removed to a fry pond, the date being August 4. The fry were not counted but were estimated at

1,000 or less, probably about 800. In the former case the parent fish had his brood near shore. They were very small, not having been off the bed more than two or three days, and the school was in compact form. Some of the new fish food was scattered over a small area, probably not over two feet across, embracing a small tuft of weeds. The whole was within a few feet of the bank so as to be well observed. The fry swam about the area referred to as long as fresh meal was put out at frequent intervals, in spite of the frantic efforts of the parent fish to get them away into deep water. They were so small that they could not be seen in the very act of taking the food, but there was no question as to the fact that they were doing so.

The case of the other brood is far more instructive and closer to the point of fish culture. Numerous exhaustive experiments have been made at this station by the writer in handling black bass fry in small ponds. All conceivable or attainable foods have been used, including plankton in quantities procured from adjoining wild ponds, and all with the most complete failure, as was also the result with this species under even more favorable conditions in Ohio under the auspices of the State Fish Commission. The fry in this pond have been fed nothing but the Chicago feed from the start to date, nearly two months, and although they have not made as rapid growth as was anticipated, they are, to all appearances, all there and doing well, there being no "big heads" or signs of cannibalism.

We believe that feeding can be carried on in the large ponds by locating the broods and feeding them while yet with the parent fish and that during the favorable weather broods can be taken out and put into the fry ponds, there to be held in readiness for shipment. We have often been delayed days and even weeks in making shipments owing to high winds and rain when, of course, broods cannot be located in the large ponds and are, therefore, often broken up and scattered about the pond to pursue their predatory instincts on their little brothers.

It takes, so they say, more than one swallow to make a spring, and we all know that some of our fondest fish-cultural hopes are ruthlessly shattered. But the writer wishes to go on record as predicting that this new food and mode of feeding will increase the output of bass in near future years as greatly as it has the sunfishes at this station this season, and that it will be equally effective on all the other species under cultivation here.

AS TO THE CARP

By W. T. HUNT

Just a word as to the humble and much-derided carp, out of my own experience with that fish, which, if more generally understood, would not be the subject of so much unjust criticism. The carp, especially fish of ten or more pounds in weight, will give the man who fishes for it with rather light tackle all the sport he desires, but its action when hooked is peculiar to itself and unlike that of any fish of my acquaintance. I have captured hundreds of large ones with an ordinary seven-ounce rod and light line and have enjoyed the sport.

I use a bait composed of flour and pulverized corn meal, with a small amount of sugar. First I mix one cup of flour with a similar amount of corn meal and then pour gradually over this one cup of boiling water, which thoroughly steams the mixture. When this is done I work it up by kneading until it is stiff and is ready for use. Sometimes I boil it for twenty minutes, but if it is properly made it will remain upon the hook without boiling. It is the best bait in this section, where the fish are plentiful in the streams. They may be taken best during the warm months.

A reel of from seventy-five to one hundred yards of strong line should be used and the rod should be fastened by driving a stiff stick between the rod and line just in front of the reel. I use pieces of rod from steel-handled umbrellas. This precaution should always be taken for the reason that if a big carp, say over ten pounds, takes the bait, it usually gives no warning but will go off in a steady pull for many yards and if the rod is loose upon the ground it goes along every time. I had a rod taken when it lay across my knees while I was mending a landing net, and I recovered it only after doing some lively swimming and diving. This carp weighed but eight pounds.

After its first rush the fish usually comes to the surface, but almost immediately goes off again and just as rapidly, with a steady pull which is almost impossible to stop. This it will repeat several times, after which it will come directly to the bank, usually at the top of the water, and sometimes upon its side. Reaching the bank, if the angler permits it to do so, it will lie with its head almost out of water and this is one of its fine tricks. Apparently it is ready to be pulled out "like an old boot," as is expressed by men who do not know, but the instant a move is made to secure it there is a tremendous splash, the tail of the fish strikes the bank and the chances are that something breaks and the man with the rod wonders why. At this point in the game many a man will carefully lay down his rod and catch the line—another fatal error—for this seems to be just the move the carp desires and it works its game. The only thing to be done, if it is a large carp, is to keep it away from the bank and this I have done by using a piece of stick, driving the fish away as soon as it gets to the bank and gradually playing it out. A big one may be finally landed with the light tackle by simply playing it until it can make no more rushes and lies helpless at the edge of the water.

As to the claim that the carp destroys game fish by eating the young, I failed utterly to prove this by making an examination, with assistance of Benjamin Cohen, a chemist, of the stomachs of a hundred carp, all over five pounds in weight. We found roots of many kinds, wild oats, grains of corn, wheat and almost all kinds of vegetable matter that grows along the stream, but no sign of fish or meat, except earthworms and waterworms, with an occasional crayfish or helgramite.

The most peculiar circumstance noted was the presence of fresh water mussels in at least ninety per cent of the fish, which seems to me to explain the disappearance of these shellfish from many streams. In the Brandywine, from which the carp were taken, were formerly millions of mussels, while at the present time few can be found on any por-

tion of the stream. We found in a few carp mussels which had just been taken and were still alive. Others had the shell just commencing to open, still others were wide open and the meaty portion decomposed and partly digested. In nearly all we found pieces of shells, sometimes as small as the end of a lead pencil and in others the entire shell just breaking into small fragments, showing that the digestive powers of the fish must be great and quick in their action.

In a number of the fish, all taken in a stretch a mile long, we found immense quantities of what looked like fish spawn except that it was black and in pellets about the size of small mustard seed. It was found only in fish from the same locality and we were puzzled until one day, walking along the stream in that section we saw two large carp close to the bank with their heads at the surface of the water nipping at small pods which hung from plants. We gathered some of the plants and the mystery was solved. It was a wild plant, introduced at this point along the stream only, several years before, in an attempt to establish a feeding ground for wild fowl. The attempt proved a failure, and the plants we found were a few survivals.

That a carp will live for an almost unlimited time out of water if it can secure enough moisture to sustain life was proved by an occurrence in the town of West Chester, Pa., a few seasons ago. A man had five large carp in a pond and one night a cloudburst washed away the embankment and left it dry with the exception of a small trickle of water through the mud in the centre. The next few days were dry and the mud became caked upon the surface. It was believed, of course, that the carp were gone down the small stream below to the Brandywine, but five days later a small boy discovered one of the carp in a small hole and captured it with a scoop net. Nearby he found a second. Then the bank was repaired and the two fish placed in the pond, but, to the surprise of everybody who noted the fact, there were five fish, all of large size, in the pond the next morning. That they had been there when the water left and had re-

mained in the damp mud was conclusively proved by the fact that one of the fish showed the identical mark of one which had been among the originals and was not one captured when the two were recovered. It had lost a portion of its dorsal fin, probably eaten from it by a mink or other animal, and this mark leads me to believe that the story is absolutely correct.

On one occasion I caught a carp weighing twenty-three pounds in a dam near Hibernia, on the Brandywine, taking it about 8 a.m. Instead of placing it in the water on a string, not trusting it on account of its size, I wrapped a piece of burlap about its gills and by dampening this probably once in two hours and keeping the fish in the shade I brought it home alive at 9 p.m., placed it in a bathtub and in two minutes it had about all the water out of the tub and had leaped out itself.

So much for my experience with the humble carp, which is not so humble after all when you have had experience with it.

DISCUSSION

PROF. L. L. DYCHE, Pratt, Kan.: I have collected material and am still collecting it for a bulletin on the German carp in Kansas. I have many notes on the German carp and would like to give some of my observations: However, I will not consume time for such a discussion at present. I might say, in regard to fishing for carp, that I have a boy 11 years old who has been able to catch some fine ones out of the Ninnescah River, a stream that runs along the north side of the fish hatchery grounds. In this stream there are many fine carp, some of which weigh as much as 15 to 20 pounds. The boy can catch these carp with ordinary fish worms. They may also be caught with corn, especially where they have been baited with corn chop. Dough-balls made from flour and cornmeal were used with success. The dough for the balls was made by cooking flour and meal together in a frying pan; it was stirred well and salted. When cooked to a thick mush or paste it was ready to be made into balls. A quart of this stuff was sometimes made into balls or pills and thrown into the water, a handful at a time, to bait the carp and to teach them to eat it, then at the proper time when the same material was used on the hook, the fish would usually bite it and could be taken with little difficulty.

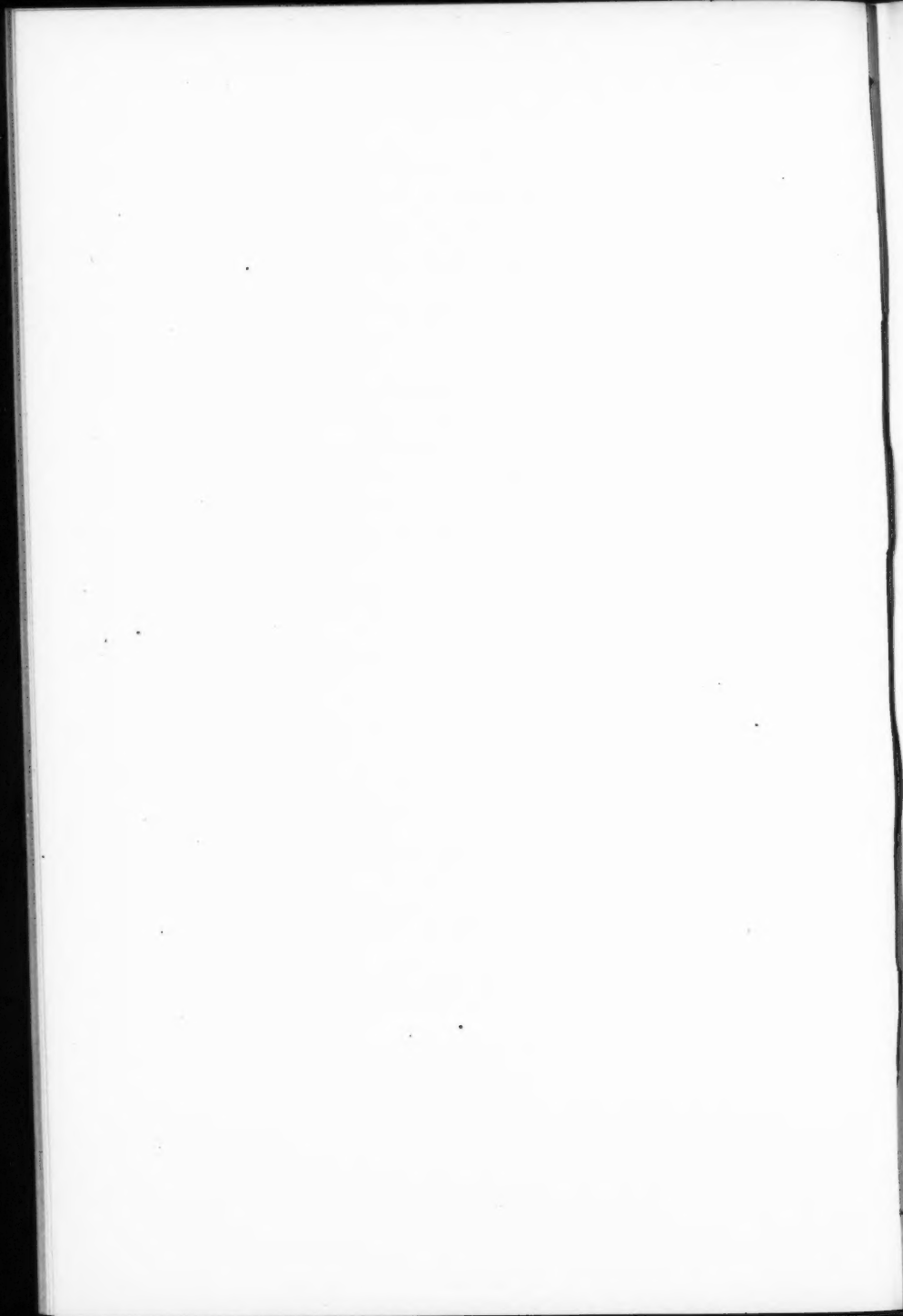
One day I saw some men interested in the boy and attempting to aid him in landing a fish. We learned that the young fellow had a

carp on his line; it had broken the pole and the boy was in the water with the line on his arm and around his legs, and was tangled up in different ways.

The carp apparently got away two or three times, but did not get loose from the hook and line; finally the boy got the fish in his arms, went ashore and threw it on the ground. The two or three kicks he gave the carp that had lacerated him with its dorsal spine was an evident outward expression of the internal feelings of the young fisherman on that particular occasion.

MR. MEEHAN: Carp fishing is becoming widespread in Pennsylvania; people are beginning to find out how to catch them, and it is becoming what they call a sporting fish. It is particularly prevalent in the Schuylkill valley and beginning to be so in the Susquehanna valley. They use as a favorite bait besides the bait suggested a half boiled potato.

PROFESSOR DYCHE: That is very good.



THE DECREASE OF THE COARSE FISH AND SOME OF ITS CAUSES

BY S. P. BARTLETT

It may be that this subject might be considered a problematical one, to some extent, and my apprehensions for the near future may be deemed premature, but to me it seems a matter of grave importance and worthy of serious consideration, that after years of work to bring about an increase in the supply of food fishes, particularly the coarser varieties, circumstances have brought about conditions which have not only materially reduced the output but which must of necessity curtail it. The rapid decrease in the supply of carp and buffalo has been most marked. Increasing for years, the output reached its highest point in 1905 and 1906, then the gradual decrease for a while was followed by the more rapid decline during the last two years in both the Mississippi and Illinois Rivers and their tributaries, until now it seems to me that the situation presents some very unpleasant probabilities unless measures are taken to offset it.

The application of protective laws, faulty at best as they have been, acted as a partial restraint to the wholesale destruction of these fish by the market fishermen. The great danger to the output does not lie here, however, but in the natural result of the rapidly increasing reclamation of what were once waste bottom lands, overflowed by the rivers in their annual floods and formerly the homes and feeding grounds of the buffalo and carp.

The Illinois River particularly presents conditions that exist in but few states, in that it lies for almost its entire length, about 250 miles, between wide, flat bottoms, which were once covered by an almost continuous chain of lakes and ponds. These bottom lands when drained by levee systems have developed into the best farming lands, and this work has been carried on so generally and so rapidly that now but a small portion remains unclaimed. This leaves

only the river itself available as a breeding ground for the fish, and while it is very productive it presents but a small area compared with the immense grounds once accessible. Under conceivable conditions there might be a question as to which would be the more profitable, the land or the water, but with conditions as they are and have been there is no doubt but that the land is the more profitable, since it can be controlled absolutely by the owner, and no question raised regarding its products, while the product of open waters under natural conditions is the property of the state until caught. This allows free fishing in the open water, and the property owner has no redress except through action for trespass, which has been a scanty protection in the many suits that have been brought from time to time. The opening of the Chicago Drainage Canal, which gave a fixed increase in the depth of the water, covered thousands of acres of land that previously were subject to cultivation. This complicated matters even more, if possible, and the only remedy for the situation was to build levee systems and reclaim the lands, if the owners were to reap any profit to themselves, and this has been done with the results to the supply of fish before explained.

Do not understand me to be in opposition to such reclamation by the owners. I am but endeavoring to show some of the causes that have led up to the present conditions, and that will ultimately result in the destruction of all the best breeding grounds of the coarse fish in this state.

There is no doubt that if the waters could be controlled in the interest of the owners the revenue to be derived from the fish would, in most cases, be greater than if the land were cultivated as farms, taking the cost of reclamation into consideration. During the past session of the Illinois General Assembly I talked with a number of owners of immense areas of water along the Illinois River, and, without exception, I think, every one of them agreed to the proposition that if their property rights were given equal protection the fishing privileges would be more profitable than

farms. With one accord they were equally agreed that they could not see their way clear to maintain preserves for the benefit of the public, and as a result levees are going in wherever it is possible to establish them. As an example of the conditions regarding ownership of fishing privileges, one might cite the case of the company, composed of men from Indianapolis, Ind., who bought Thompson, Grassy and Seib Lakes above Havana, Ill. The property covers an area of thousands of acres in water and marshy lands, and was bought for a hunting and fishing preserve, but at no time have they been permitted to have control of their property, for reasons given, until now they are ready to quit, and the proposition to incorporate for a levee district is being considered. Spring Lake, seven miles long, with varying width, below Pekin, Ill., once one of the famous bass waters of the state, also affording hundreds of acres of flat ponds for the coarse fish, is now in a levee district.

These are the existing conditions, but a remedy suggests itself. There yet remain several thousand acres of water available for the purpose of breeding grounds for the coarse fishes. Thompson and allied lakes, mentioned before, might be reserved for such purpose, if they could be properly controlled and protected by government or state ownership, either by lease or purchase. Such a reservation could be open to the public for angling, under proper restrictions, and closely protected during spawning season. This would assure a constant and increasing supply of young fish for the river, and do much toward offsetting present conditions.

In our state a movement is on foot to induce the state to take over a number of such places, and an arrangement has been made to meet the owners, and endeavor to secure such options as will make possible a proposition to the legislature covering the desired measure.

One of the greatest difficulties in the way, however, is the attitude of the people in general toward the whole subject of fish propagation and distribution. Now when the game question is considered, there has been no trouble in

securing all the money needed. Over \$100,000 annually is made for the protection and increase of game, with game farms and preserves controlled by the state, and all of it in the interest of the sportsmen. Yet this is an interest that does not in any way affect the consumer or commercial interests. Game is protected from sale, and to be enjoyed must be the product of the hunt or gift. I am not in any sense finding fault with the protection and propagation of game. It is a magnificent measure and in this state, under Commissioner Wheeler's management, has reached the high water mark of success, being wholly self-sustaining by its business provisions. But I cannot help drawing comparisons, as to the direct value to the people generally, between that interest and the preservation to the ordinary consumer of the immense output of food represented by the fishes of the state which might be conserved for their benefit with less expenditure.

Thence, the question of securing such measures as will insure a future supply at a moderate cost to the people seems to be justified. We are now at a point in our state where we shall have to meet these contingencies quickly, if the future is to be considered at all. I presume similar conditions exist elsewhere, and while they may vary to some extent, according to environments, yet the one great fact remains everywhere: Fish are an important factor in the food supply, and to conserve them we must meet and conquer adverse conditions or find too late that neglect has proved fatal.

The decrease in the output of carp in the Illinois and Mississippi Rivers is quite sixty per cent of its highest figures, and is a serious matter, commercially and from the standpoint of home food which is furnished for the taking.

I note these points and offer them to you and others interested in such matters with a view to provoking, if possible, discussion that may result in overcoming the conditions, or at least cause attention to be drawn to them with ultimate good results. In my opinion, no greater work has ever been taken up by government or state than the conser-

vation of natural resources, and of them all fish, it seems to me, is one of the most important.

DISCUSSION

DR. S. P. BARTLETT: The proposition advanced is a simple one and applicable, so far as I know, only to the state of Illinois, and my purpose in offering the paper at all was rather to provoke discussion and ascertain, if possible, by that discussion whether other states are situated similarly to Illinois. The Illinois River for years has been noted for its great productiveness of coarse fish. Now, when I talk about coarse fish, I mean that in 1860 the output of buffalo along that river was in the millions of pounds. In 1880 the output of buffalo along the Illinois River had been reduced to about 1,000,000 pounds. The introduction of carp sent those figures up to 22,000,000 pounds of coarse fish in 1896. In the last five years the output of carp from the Illinois River has been reduced nearly 60 per cent. Now, there is a cause for that, and that cause until lately I had attributed alone to the fact of their taking in so much of the Illinois River, which is 250 miles in length with about five to six miles bottom on both sides, practically interwoven with nice beautiful lakes for its full length. All of these lakes and all of these flat places provided excellent breeding grounds for the carp.

Within the last eight or ten years a gradual encroachment upon these breeding ponds has been made by what is known as levee districts, until probably all but about 20 per cent of that entire district is taken up in these levee districts; that is to say, they are reclaiming the land and using it for farming purposes. The reasons for that I give in my paper, but that is immaterial in getting at the point I wish to reach. The point I want to make is that within the next ten years the Illinois River, probably the greatest coarse fish producing stream in the United States today, will be practically depleted of its breeding grounds on account of the encroachment of these levee districts, which will cut them off entirely. Now what I want to plead for at the next or some future session of the legislature is that the state should own and control enough land, keeping it outside of levee districts, to make public parks or preserves for the purpose of furnishing a supply of coarse fish for the Illinois River, thus preserving what will soon be depleted. This paper is not intended to educate anybody, but simply to give the conditions now prevalent along that river, and to ascertain, if possible, whether other states of the union have such a thing as a state preserve.

We have now large bodies of water along the Illinois River that are owned practically by hunting and fishing clubs. There are half a dozen of them on which a large amount of money has been expended for the benefit of these clubs.

Under a late decision of our Supreme Court they have made all waters that can be traversed by a launch for commercial purposes, navigable streams, and on such the fishermen are at liberty to go without

interference, no matter what protests there may be from the owners. In other words, the owners of that submerged land, made so by the introduction of the water from the drainage canal, which was once farmland, are prevented from reaping the benefit of the product of their waters by retaining the right to take out fish from these waters, or from disposing of the waters under lease or sale. The owners of this land in many instances have done the only thing that they could do, namely, to put their land into levee districts and in some way get their money back on their investment.

I want to know whether anywhere within the states such a thing as a state preserve or a state reservation could be named. We are going to agitate the procurement in our state, either by lease or purchase, of these tracts now lying outside of the levee districts, and make them breeding grounds for coarser fishes; and while I have said that the Illinois River is the most productive river in the United States for coarse fish, it is also the greatest bass stream in the state of Illinois, and I have attributed that, of late years, to the fact that the carp, on account of their rapid reproduction, are furnishing food for the bass. As a consequence, of course, if my argument is correct, as the carp disappear so must the bass.

I believed this was the cause of the disappearance of the carp from the Illinois River, when I had a talk with Dr. Forbes, and he gave me some information which puts new light on a great deal of the subject. He tells me that at one place on the Illinois River 350 acres, which he or his assistants had carefully measured, produced half a billion eggs; and he said that by careful daily observation and investigation it was shown that less than 2 per cent of the eggs of the carp were hatched in the year 1910, owing to the fact that they had fallen or were lying upon a decomposing mass of weeds and plants and other things of that kind and were utterly ruined, and that none of the fry in that 350 acres of land ever found its way out, but perished with the receding waters in the hot weather. That is an appalling condition of affairs to those of us on the river who have watched a large commercial interest develop and then suffer a decline. Over \$1,000,000 a year has been taken out of that river in the shipment of coarse fish to the East. For several years buffalo were practically extinct, but are now becoming more plentiful.

There is one other subject I want to speak about in connection with that matter, which I hope the Committee on Resolutions will take broad grounds on and put in such shape that we can all use it with our legislatures. I have been before them for 35 years and I know the difficulties that we encounter—I refer to pollution of waters. Take our finest streams in the state of Illinois, the Rock, Fox and Kankakee Rivers, and they have become simply sewers. I made an examination of the Fox where there was once a rocky bottom. Now the bottom is covered with four or five feet of black muck, which is almost unbearable for its stench when brought to the top.

DR. G. W. FIELD, Boston, Mass.: In answer to the questions of the gentleman from Illinois I might say that the state of Massachusetts has maintained Buzzards Bay for the last 15 or 20 years as a breeding place for salt water fish, in which no seining has been allowed—only hand line fishing. Buzzards Bay is 20 miles long and 215 miles wide. We have also a similar place farther down the cape, relatively of small size, where no seining is allowed.

All the state ponds of Massachusetts above 20 acres in area are fished only by a single hook and line; no seining is allowed. The same is true of the rivers. The conditions are not exactly parallel with those in Illinois, as we have only a few carp. They were introduced some years ago in Laurel Lake in the Berkshires. I understand there is but little water left in the lake and the rest is carp. The wealthy residents complain that the carp come into the gardens and pick the strawberries. (Laughter.)

DR. BARTLETT: Is it possible for me to obtain a copy of the laws bearing on that subject?

DR. FIELD: I will see that you get copies.

MR. D. B. FEARING, Newport, R. I.: I would like to tell you a carp story. I used to live in California at a place called Upper Lake, and to get there in those days, there being no railroad, one had to go by stage coach and cross the Russian River. During the spawning season of the steelhead trout I have seen anywhere from six to a dozen or more of the trout killed by the wheels of the coach and the horses' feet. The fishing was excellent in Upper Lake, and there were myriads of canvasback, redhead and wood ducks to be killed. About 25 years ago a German turned an aquarium full of carp into the lower lake, and today there is not a steelhead trout in either the upper or lower lake; there is not a wild duck to be found; there is nothing but carp.

DR. BARTLETT: I have long been abused on account of the carp. I could not come into the room but some one would shout: "Here comes old carp." A number of states enacted legislation against the introduction of carp, and their defense made me quite notorious all over the country. The carp has been wrongfully abused, and in line with what has been said I want to read you a telegram that got into the Associated Press dispatches in the Illinois papers, to show you that there are two sides to the question.

"CALLS BLACK BASS CANNIBALS

VETERAN ILLINOIS FISHERMAN SAYS THAT THEY EAT UP OTHER VARIETIES

Bloomington, Ill., October 1.—Mr. Lawrence, a veteran fisherman of the Illinois River, thinks that the new fishing law has many bad points. He asserts that it is useless for fishermen who seine black bass to return them to the water, insisting that every black bass that has been gilled will die, or will be just as good as dead when it gets to the net. He enters a severe indictment against the bass, claiming that they have pronounced cannibalistic instinct, and are the most voracious destroyers of young fish and spawn on the river. As they increase under the protection of the law, the other varieties will decrease. So between the cannibals and their protection, other species will be destroyed and black bass placed in the ascendancy. Mr. Lawrence says black bass were never so plentiful as on the Illinois; and the great increase is due to the thorough protection of them."

MR. MEEHAN: We have a saying in Pennsylvania that it is always unsafe for anyone to say that any particular fish is very destructive and ought to be exterminated, because by so doing he is very likely to tread on the tail of his favorite fish. (Laughter.)

MR. J. S. P. H. WILSON, Auburn, Me.: I come from the state of Maine and we boast the most beautiful waters and fish in this union. I came down here for information. Now the most important question I want to ask is this, how to keep the carp out of the state of Maine. I am afraid they may walk overland and get into our waters.

DR. TARLETON H. BEAN, Albany, N. Y.: As I understand, this is not a carp controversy, and I will not talk about carp, but I would like to say to Dr. Bartlett that on the question of what the states are doing to protect the breeding grounds of certain fish, New York has within its own forest reserves certain lakes which are absolutely protected against fishing of all kinds, and kept for breeding grounds of brook trout, lake trout, white fish, and other valuable species. There are large lakes in the Adirondacks; one is near the hatchery at Saranac Lake, and although called Little Green Lake, it is a large lake. There is also a larger Green Lake in the same region, but only one of these is reserved by the state as a breeding ground for certain kinds of fish. Then on Long Island there is Great South Bay, which, as you know, is an immense body of water, and it is almost entirely protected from fishing of all kinds except with hook and line. Great South Bay is perhaps as fine a body of water for the breeding of weakfish, scup and sea bass, as any piece of water in New York.

Then again there is a law in New York which forbids the seining of smelt in trout waters. That protects the smelt because they run up in the trout streams to cast their eggs in very shallow water. The smelt is so common that anyone can obtain a mess of it. Great South Bay has been so thoroughly restocked by natural processes that the fishing is better now than when I first spent my summers there 25 or 30 years ago. You will see that the state has various grounds which cannot be encroached upon by anyone except hook and line fishermen without incurring risk of heavy penalties. A great deal of good has been accomplished in this way. The New York law might be a good one for Dr. Bartlett.

DR. BARTLETT: I should like to have it very much.

DR. H. B. WARD, Urbana, Ill.: I was very much struck by the remark that was made by the last speaker, Dr. Bean, in mentioning the maintenance of certain lakes in the forest reservation as preserves for the breeding of trout.

Being a New York man myself, I think perhaps I appreciate more than some of those who have always or never lived in Illinois, the peculiar character of this Illinois River. It is really a very remarkable stream. In the course of the valley, the immediate plain of the river, there are large areas of back water, cut-offs, sloughs or bayous, places which connect with the open river and yet are of an entirely different

biological character. They are quiet waters with an abundant opportunity for plant growth and with splendid areas for the development of young fish. The progress of the conquest of the land leads naturally to the reclaiming of these areas. Cultivated land bordering on the river is of considerable value. An organization with financial means gets the right to control a certain part of the back water, puts up there a dyke or levee and brings the whole area under cultivation. The inevitable result of that tendency is to confine the river to a relatively narrow channel, to make of it, in other words, a canal.

By the very clear presentation which Dr. Forbes gave the matter this morning, you can see the inevitable result of the increase of pollution and the springing up of cities on the banks of a river. It becomes for large portions of its course, and during the summer season at least, a septic tank or an open sewer, if you please to call it so, where the conditions of existence are so radically changed that fish cannot maintain themselves.

Now, while other states, with a different type of land, will have in their forest preserves or elsewhere, opportunities for the breeding of fish, there is apparently only one way in which the state of Illinois can gain such opportunities, and that is through a new and untried and perhaps an unwelcome method of treatment, namely, the acquirement by the state of the right in fee simple to certain of these areas and their preservation under natural conditions. For the fish live up in these back waters, in those creeks, and the expansion of the river where the water is still pure; they live happily there when the conditions in the main river are such that they cannot maintain themselves there; and you will recall that Dr. Forbes gave examples of that this morning.

It seems like a strange thing for a state to acquire a considerable area of swamp land or of overflow land; and yet after all, gentlemen, that is directly along the line which the state follows in securing tracts of beautiful mountain or forest land; it is for the preservation of natural conditions for future generations.

The maintenance of the fish supply is of real importance to the state. It cannot be maintained if the river is narrowed down, in this case, to a plain channel through which the sweep of the sewage-contaminated water eliminates all possibilities of fish existence.

There must be set aside for the people, for the state, some of these areas of back-water land, where the natural conditions of quiet water, of plant growth and other conditions favorable for the existence of fish shall be maintained. So, strange as it may seem, the state is to be called upon to preserve for itself and for the maintenance of its fisheries and for use of its citizens a type of nature that is fast disappearing, and to maintain in perpetuity a certain part of this land unchanged in order that suitable conditions for fish existence may be afforded, and that the generations to come may see something of the wild bottom land in which the fishes now live.

While from one standpoint that appears strange, yet, to my mind, it is precisely identical with the movement which calls for the preservation of the forest and mountain areas where game of the bird type or of the mammalian type live, which will give to the citizens of the state and to subsequent generations, an opportunity whereby there can be experienced the enjoyment of the woods and mountains.

I know of nothing in other states to the eastward which is really parallel to the condition which exists in the valley of the Illinois River. I wish the members might have the opportunity to go up and down the Illinois—not to see this main channel of the river, but to have a chance to wander in a boat out into these enormous side-arms of the stream, and see the beautiful lakes that have been developed there by Nature, and the splendid opportunities that these fish have for existence.

I can say as a stranger who has recently come to the state of Illinois that it is a revelation to any man to see the character of those lakes; and there are some of them which I have been privileged to visit that are miles in length, as well as hundreds and perhaps thousands of acres in area. If at any time this Society should have the opportunity to visit one of those lakes and to see the natural conditions which still obtain there, I am sure that you would feel like joining with us of Illinois in demanding that some way or other something of that type should be preserved. (Applause.)

DR. BEAN: Just a word more. I neglected to state that New York had another resource in the shape of feeding grounds for fish, in its artificial water ways. In the fall of each year the Conservation Commission, which now includes the old Forest Fish and Game Commission, is invited to send experienced men to the vicinity of Rochester to collect fishes which have grown up in the canal, in what they call the east and west waters. The number of good fish taken that way is almost startling. It includes black bass, pike-perch, calico bass, rock bass and various other good fishes. So that in addition to its preserves the state has artificial breeding grounds for fish from which it has drawn large stores.

MR. H. WHEELER PERCE, Chicago, Ill.: Coming from Illinois, I would like to put in a plea for the assistance of this Society in bringing about the conditions Dr. Bartlett referred to, which are much desired by those of us in Illinois acquainted with the situation and advocating fish conservation.

It would seem to me at a casual glance, that a knowledge of any enactment of any state setting aside for the permanent use of the state some particular section of land, whether it be mountain land, water land, prairie land or forest land, would help us in any efforts that we may make for the preservation of this section of the country spoken of by Dr. Bartlett. Surely some members of this Society can aid us materially by advising of what has been accomplished, and in what manner, in their own state or locality.

MR. E. T. GRETHIER, St. Louis, Mo.: In regard to Missouri taking part in setting aside a tract of land, regularly every two years we have a political fight over our game and fish laws, and we have to battle pro and con to keep our laws on the books. At the last session of the legislature, to give additional interest to the matter, we attempted to purchase $11\frac{1}{2}$ square miles of land in a most beautiful place 30 miles from a railroad, and having a number of fine improvements in the form of buildings, one of them with 60 rooms worth over \$100,000, and another one used as a garage valued at about \$10,000, there being about \$160,000 already in improvements on that property. In this $11\frac{1}{2}$ acres is a wonderful tract of natural scenic beauty, with caves and subterranean passages, lakes, waterfalls, rocks, etc., a vast amphitheatre, with natural caves, bridges, etc., a good trout stream and bass streams. We wanted to have it set aside as a state park, and we thought in addition to doing so conditions were such that we could buy the tract for \$160,000. We found we could. We had a surplus in the fund of about \$45,000 at the beginning of the year when the legislature was in session. We thought if we could buy it we would interest the people of the state in it for a summer resort, for bungalows, also for fish and game improvement and interest the sportsmen. We would also put aside a sum of money annually out of our game fund and commit the state to the purchase of that tract, thus perpetrating the hunting license feature of our game and fish laws, which has always been attacked by a retrogressive element in the state legislature. By making the first small payment the state would have been committed to a policy of revenues now in vogue, and also prevent the excess collections, above game warden salaries, etc., from being diverted to other purposes than for which it was collected. By making only a small payment the property would be secured.

We came within one vote of purchasing that tract and we expect to try again. We want to use it as a place where we can raise game and fish, not so much to allow people to kill game, but to see the varieties of game in a natural state, and for fishing opportunities for a great number of people. The improvements on the ground in the way of buildings, pumping station, etc., are worth more than the price of the land itself. We argued and sent pictures to show the beautiful scenery, and we had assurance from one of the railroads that they would build in as soon as the state took charge. A wealthy gentleman had purchased the land, but he was killed in an automobile accident, and the property is now for sale. The nature of the country is such that sitting high on the rocks and cliffs it is almost like a view of Switzerland. We tried and fought just as hard as we could to accomplish our desires, and we have tried to give them good service in our game and fish department here, but we still have strong opposition. I want to congratulate Professor Dyche on the success of the work which he does before the Kansas Legislature, but we have more trouble in our state. Every two years I have been one of several persons that go

before the legislature and have a regular fight; various interests represented there have even fought our plan. If we had carried it through, we would have had something as fine as anything in Colorado. A great many of our people do not know about it. For the benefit of Dr. Bartlett I will say that it is one of the things that Missouri tried in the way of setting aside land to aid in our work, but failed on by one vote.

THE DISTRIBUTION AND FREQUENCY OF ANIMAL PARASITES AND PARASITIC DIS- EASES IN NORTH AMERICAN FRESH- WATER FISH.*

BY HENRY B. WARD

In his valuable work on fish diseases, Hofer (1906) distinguishes two types of general infectious diseases: those caused by bacteria and those produced by Sporozoa. Special diseases of individual organs he classifies as due to mechanical causes, to chemical influences, to disturbances of nutrition, and as parasitic diseases either of plant or animal origin. Under the last heading—parasitic diseases of particular organs due to animal parasites—he differentiates further those due to Protozoa, to worms, and to crustacea of various sorts, noting the occurrence of several hundred different animal parasites in European fish and recording more than one hundred specific diseases which are due to their action. This work is of great value both to the practical fish culturist and to the scientific student. It stands, however, alone as a general work in this field and the only information available in English consists of widely scattered notes in works on other topics or of brief special papers published in journals often generally inaccessible. In either case it is difficult to trace these items and still more difficult to secure them, so that usually one is unable to make any use of the material they contain.

Two years ago Dr. T. H. Bean read before this Society a paper entitled, "A Plea for the Systematic Study of Fish Diseases." He emphasized our scanty knowledge of the cause and treatment of fish diseases and the inadequate allotment for scientific inquiry in such lines compared to the economic value of the researches. He added a brief and

*Contributions from the Zoological Laboratory of the University of Illinois, No. 13.

confessedly incomplete bibliography on the subject with most valuable abstracts of the more general and extensive articles. This bibliography covers all types of diseases, including such as are of unknown origin as well as those due to plant and to animal parasites. We are certainly indebted to Dr. Bean for calling attention forcibly to the needs in this field, and for one, I resolved at once to do what I could toward remedying the defect in the particular line with which I was familiar. With this end in view I have brought together all records of parasites in North American freshwater fishes that have been published up to date, and have added records of my own observations taken from field notes. With these I have included records of material obtained by various other investigators who have been kind enough to place their collections at my disposal from time to time. Some collections were not large, others were of considerable size. All were alike valuable in furnishing evidence as to the abundance and range of various parasites, the host species infested, and seasonal or other factors that influence their occurrence and importance.

Among the important fish diseases are those which have been ascertained to be due to parasitic organisms. These are of two types: 1. Diseases which are caused by the invasion of plant parasites such as fungus, moulds, and bacteria. 2. Such as are attributable to animal parasites. The latter are of relatively recent discovery. In most cases they are as yet imperfectly known and their number will doubtless be considerably augmented with the progress of knowledge in this field. Through study diseases of unknown origin are being traced to definite causes, and in the majority of instances the cause is found to be a plant or animal parasite.

While the part of the lower plants in producing disease has long been known, the corresponding rôle of animal organisms is a subject of relatively recent consideration. Consequently it may be valuable to outline very briefly the recognized ways in which animals may be related to the cause

and spread of disease. (For a fuller discussion consult Ward, 1905; see list at the close of this paper.)

Animals may be merely mechanical carriers of disease transporting the causal organisms from one point to another, as flies transport typhoid germs or eggs of parasitic worms. They may be breeders of disease when the germs go through processes of multiplication within the body of the carrier and the number of infecting organisms is greatly increased thereby. This is the case with the germs of malaria, which multiply in the body of the mosquito. In this instance the latter is an essential condition for the spread of the disease; it is hence a breeder as well as a transmitter of disease. Finally animal organisms may be definite producers of disease; and many among the various types of animal parasites belong in this class.

To comprehend rightly the standing of parasites as disease-producers, it is necessary to review briefly the effects which the parasite exerts on its host. Here again the limits of the occasion demand extreme conciseness and I may refer those especially interested to a more extended discussion of the topic which I have published elsewhere (Ward, 1907).

Among the vertebrates, the only instance of a species which definitely causes disease is that of the lamprey. Its well known action on the outside of the body is distinctly analogous to that of the hookworm in the intestines. Usually disease-producing animals are small or at least gain access to the body of the host in a stage of development which is insignificant in size. Among the Crustacea and Insecta one finds some groups highly modified to adapt them to external parasitism and certain of these will demand attention later in this paper; there are, however, only a few of them that are internal parasites. The worms furnish some ectoparasites on water-living hosts and a large number of endoparasites which infest all types of animals and produce many serious diseases. But in the group of minute single-celled animals, the Protozoa, are found the most

numerous and most serious disease-producers. The effects they produce are as varied as the species which produce them. In one respect only do they differ from the higher parasites. They have usually the power of multiplying within the host animal, a power which most higher parasites do not possess, and accordingly, even though the original infection be inconsiderable, the number of parasites may increase beyond the ability of the host to resist their attacks. The Protozoa include thus the most dangerous animal parasites.

The effects of the parasite on the host may be classified roughly as mechanical, structural, or functional. Purely mechanical injuries, such as the stoppage of the alimentary canal or any other passage way, pressure of the parasite on important tissues, the irritation of delicate structures by movement or the distortion of organs, though found among fishes, are nevertheless rare and of distinctly secondary importance. Hofer mentions a number of such cases in European fish, and notes their rarity. Similar troubles doubtless occur among fish in our own waters, but their infrequency renders them of little practical importance and I have been unable to find any mention of them in the literature.

Structural changes, such as the proliferation of muscle, or other cells, are frequently produced by the protozoan parasites. The importance of parasitic invasion is here clearly related to the numbers and size of the parasites, and in most cases the action of a few is insignificant, whereas the influence of a greater number or of such as may be relatively large is a serious factor in the economy of the fish. The location of the parasite is also important, and most serious effects are produced by insignificant organisms in the nervous system or other delicate or important structures. All of these features are as yet relatively unstudied in the case of fish parasites. Even in Europe where investigations have been more extended because the culture of fishes has been pursued as a commercial undertaking for more than a century, observations on these points are scanty and unsatisfac-

tory, while in this country the only references consist of meager notes, scattered through a mass of other material. There is no doubt that special diseases exist, but we know next to nothing of their distribution or of their frequency. So far as methods for the relief of the difficulty are concerned the American fish culturists may follow with safety the processes already worked out in the old world.

Giard was the first to discuss a widespread phenomenon of biological importance, which he named parasitic castration. This is of most frequent occurrence among invertebrates, especially Crustacea; it consists in the reduction and ultimate destruction of the reproductive power in consequence of parasitic invasion. The effect is produced directly or indirectly; in the one case by the actual destruction of the sexual glands and in the other by the subtraction of so much nourishment that these glands remain in an undeveloped condition and are not functional. The condition has not been reported previously from fishes, but is, I think, not an uncommon occurrence. At least I have examined fish of several species in which the sexual glands were atrophied as the evident results of large parasitic infestation. One of these was a rainbow trout sent me from a hatchery. This condition deserves careful attention, as the effect is evidently serious in fish culture since it attacks the very element in the fish which is of supreme importance to the fish culturist, viz, the reproductive power.

One further fact deserves especial mention. The effects produced by parasites have been determined by a study of the conditions in higher animals. Economic reasons have limited the study almost entirely to man and the important domestic animals. For the water-living animals one can find no regular, systematic, or extended studies. The casual notes of investigators occupied with other problems yield all the definite information at our command. Beyond this dependence must be placed on inferences from known conditions in higher groups. It is evident without further dis-

cussion that this is at best an unstable foundation on which to erect so important a structure.

Our knowledge concerning the parasites of fresh-water fish in North America is due first of all to the researches of Dr. Joseph Leidy, a former distinguished physician and naturalist of Philadelphia, who studied and recorded the occurrence of many species from American fish. It is said of him that he was accustomed to visit regularly the local fish market in search of parasites and the discovery of a new or unusual form was a constant source of pleasure. His contributions are numerous and valuable and his collection is the most extensive yet on record in this country. It has been listed by Stiles and Hassall (1894).

The records of Verrill cover chiefly the parasites of marine fishes, and those of Linton are largely the same although the latter has published several very important papers on the parasites of fresh-water fishes; these are duly entered and annotated in the appended bibliography. Ramsey Wright, Stiles and Hassall, Pratt, and Calkins have also contributed important articles on this topic which, with others of perhaps equal importance though more limited in extent, are all included in the bibliography. From the standpoint of the fish culturist the papers by Bean, Clark and Marsh, among others, are deserving of especial mention. Though embracing many titles the bibliography is probably incomplete, even for the limited field it attempts to cover.

The simplest of animal organisms are the single-celled forms or Protozoa. Among these there are three groups, the Sporozoa, the Flagellata, and the Ciliata, which furnish disease-producing organisms harmful to the fishes. Undoubtedly the most important are the Sporozoa, which invoke general diseases of frequent occurrence and serious in effect. These organisms reproduce with extreme rapidity, giving rise to a mass of individual parasites that invade the different organs and tissues of the fish, bringing about changes in various structures that ultimately endanger the life of the host.

Among the various groups of Sporozoa the Myxosporidia are peculiarly characteristic fish parasites. Many of them occur generally throughout the organs of the fish, although others confine their attacks to special organs or systems. These forms affect chiefly the skin of the fish, yet are commonly found in the gills, forming numerous nodules on the gill filaments. Other species inhabit the intestine or liver, and give rise to general epidemics of the most serious type. Two species among these, *Myxobolus cyprini* and *Myxobolus pfeifferi*, give rise to two of the best known and most dangerous fish epidemics of Europe: the carp pox and the catfish boil diseases. Of a similar character is the nodular disease of minnow and stickleback.

In 1894 Gurley published an extensive monograph on the psorosperms of fishes, in which he listed, from various parts of the world, 70 valid species and 26 doubtful forms. These were obtained from 76 lost species. Only 9 species are listed from North America and but 7 of these come from freshwater fishes. Exceedingly valuable tables on distribution and systematic keys make the work generally useful. Of North American species he says that *Myxobolus oblongus* Gurley from the chub-sucker is numerous on fish from Mississippi and rare on those from other localities. *M. globosus* was found on the same host from North and South Carolina and from Mississippi. *M. transvalis* was present rarely on shiners from Virginia. *M. monurus* occurred on the pike-perch from New Jersey and *M. macrurus* on a Texas minnow. *M. linearis* was collected on the bullhead from Iowa. This brief list shows at once a wide range both of localities and hosts for the few parasitic species. These forms are, however, not so rare here as this record would seem to indicate. In conversation with various persons, I have learned that such parasites are frequently met with, and in one case at least have produced an epidemic at a hatchery. Unfortunately it was impossible to secure material for study and determination as the time had gone by and the species present must remain undetermined. That other yet undescribed

species exist in this country, I cannot doubt, in view of my own experience. In several cases I have seen infections of *Myxosporidia* which could not be identified as known species. These forms should receive careful attention with a view to determining fully the species present in this country, together with their frequency, their range, and the factors which determine their occasional serious increase in numbers.

A related form which also belongs in this subdivision is the organism that produces an epidemic among brook trout, *Lymphosporidium truttae*. The minute spores are found in all organs, and sharply limited deep ulcers appear on the fish and extend into the internal organs. These epidemics are extremely fatal among brook trout of all ages. The parasite has been carefully studied by Calkins, who inclines to the view that the fish may not be its original host, as similar organisms are found in the body cavity of various small Crustacea and the trout become infected by swallowing such Crustacea containing the Protozoa. The method recommended for handling this disease includes the destruction of diseased fish, the draining of infected ponds, and their exposure to the sun. If interbreeding of diseased fish is avoided and the water kept clear and cool as well as other means taken to sustain the vitality of the fish and prevent deterioration through inbreeding, the disease can be kept under. Marsh has recommended that the fish culturist avoid over-crowding and transfer diseased fish to larger quarters with more rapid flow of water. The disinfection of ponds by chloride of lime or copper sulphate appears to be of value.

Among the flagellate protozoans there are only two forms which call for more than passing consideration. The species known as *Costia necatrix* produces a serious and well-characterized disease among trout, goldfish, and other aquarium inhabitants. The skin of the fish loses color and becomes cloudy in spots. This effect is due to the assemblage at the surface of an enormous number of the microscopic flagellates. They are usually anchored to the skin by their long flagella. Treatment of the fish with two per cent

salt solution for one-half an hour results in the destruction of the parasite and the cure of the disease. Other flagellate Protozoa belonging to the group commonly designated as trypanosomes are known to occur rather commonly in the blood of European fish; thus far observations have not been made on the occurrence of these forms in North America, nor do we know much concerning their abundance or importance even in Europe. Other forms of this group are the cause of serious and widespread epidemics among domesticated animals in various parts of the world. One would readily infer that parasites of this type in fish may exercise a similar destructive influence on their host.

The most widely distributed and most dangerous disease caused by ciliate Protozoa is due to *Ichthiophthirius*. Well known and feared in the old world for its ravages among fish in aquaria, in breeding tanks, and even in fish ponds, it occurs also in North America. At the World's Columbian Exposition in Chicago, in 1893, it attacked the fish in the Fisheries exhibit and did considerable damage. Because of the descriptions published in connection with that epidemic it is fairly well known in this country. The parasite is a minute oval body which when young bores into the skin of the fish and produces there a small pustule in which it lives on the degenerated dermal cells and after reaching full development forms a cyst and falls out. In a brief period hundreds and even thousands of such minute bladders and the resulting tiny orifices cover the skin of the fish until it is destroyed and the fish succumbs to the disease. Means of cure have not yet been successfully introduced and prevention is the only effective protection.

Skin infections due to other species of ciliate Protozoa are known in Europe to attack carp, goldfish, eels, and trout. They are prominent in fish confined in aquaria, or in small basins, if not exclusively limited to such conditions. In particular among goldfish these attacks become epidemics of the most serious character. Careful investigations are needed to determine whether somewhat similar epidemics

popularly reported in this country are caused by the same or related parasites.

Among the parasitic worms three types occur in fish: The Trematoda or flukes, the Cestoda or tapeworms, and the Nematoda, roundworms or threadworms. A few of the flukes are found living on the skin of fish as external parasites, but these are confined to marine species and deserve only passing mention here. All the rest of the forms mentioned which are parasitic in fish occur within the body and are regarded as internal parasites, even though some of them on the mouth or on the gills have practically the same conditions of existence as are found on the external surface and are very similar in structure to the species of external parasites that live on the skin of marine fish.

A few of these internal parasites live in the body cavity and come to notice when the fish are cleaned, a few others occur embedded in muscle tissue or at other points and are sufficiently conspicuous to attract attention at that time or later, but the large majority of such forms inhabit the alimentary canal, liver, swimming bladder, or other visceral organs. They are removed in toto with the viscera and only rarely are recognized as present. They are nevertheless the most important forms both from the hygienic and from the economic standpoint.

Where only a few internal parasites are present their influence on the fish is relatively unimportant except in so far as they form the basis for an infection which under favorable circumstances may increase to far greater proportions. The breaking out of parasitic epidemics is well known and is justly regarded with apprehension, for both among wild fish and among such as are held in control, such epidemics have appeared suddenly and in a brief period have swept away the results of years of labor on the part of the fish culturist. But even where no epidemic breaks out there is a distinct loss, since the influence of parasites reduces the reproductive power of the fish and also its power to grow and to lay on flesh. Now these are precisely the factors in

the biology of the fish which are of the greatest commercial importance and hence even in the ordinary case a mild parasitic infection is costly. When one adds the possibility that at any moment a serious epidemic may break out it is apparent how important is a knowledge of the degree of parasitic infection, of the means by which this infection is spread, and of the methods by which it may be reduced.

So far as man is concerned almost all of these parasites are harmless—*i. e.*, they do not have the power, even if transported in a living condition to the human alimentary canal, to establish themselves there. As the viscera are removed before the fish is cooked, smoked, salted, or otherwise prepared, such a transfer is possible only when the parasites are encysted in the flesh or are found in the body cavity. In the case of the eggs used in making caviar, such parasites as were not destroyed by the method of preparation would be carried into the human intestine and bring about an infection. The only important parasite undoubtedly transferred to man in the flesh or among the ova of the fish is the larva of the fish or broad tapeworm, *Dibothriocephalus latus*. Infection by this species is very common in some fish-eating people of Europe but, though known, is very rare in America. Cooking destroys the life of this parasite but salting and smoking do not always do so.

For some time I have been studying the parasitic worms of fish and have accumulated data looking toward the solution of their questions. At the time of making the first collections I published a brief note (Ward, 1894c) on this topic. Now in the light of more abundant evidence it is possible to speak with greater definiteness on the subject.

All of the records utilized here were taken from collections made by me or under my direction and great care has been exercised to reach the maximum accuracy. They relate to fresh-water fish or to such migrants as spend a portion of their existence in fresh water. In all, the records cover 991 fish belonging to 62 species. Only 179 fish were uninfected. (Table, p. 226 and 227.)

In general, then, very few fish are free from internal parasites. The lightest infection is found in the carp, an introduced species, and in the minnows and other small stream fish. In the carp, which was introduced in the egg stage, it is natural that the number of parasites should be smaller than usual in fish of similar types and far smaller than characterizes the same species in its home in continental Europe. It has here only the parasites of American origin that could secondarily adapt themselves to its habits and the brief time since its introduction has not been adequate for the acquirement of an extensive parasitic population. Only an occasional individual of this species is at all affected by internal parasites. Among the fish of small streams the conditions are unfavorable for infection. The territory is limited, unconnected with other regions, constantly drained of its organisms, and parasitic forms are not likely to gain a footing. But because of its limitations it is easy to see that when parasites are once introduced the infection is likely to be heavy. It would be expected, then, that the records would show either that parasites were absent or were abundant, and furthermore that this difference was associated with definite regions. The evidence, while perhaps not conclusive, clearly indicates the conditions noted. In all, ten fish among those examined failed to yield any evidence of parasitic invasion.

On the other hand there are not many fish in which the infection appears excessive. The tables show at a glance the extent of infection, which can be taken from the column indicating the average infection. One possible difficulty must be avoided in making such a comparison. The numbers do not indicate the relative size of the parasite, which is an important factor in the effect produced. Especially among the cestodes, or tapeworms, is this difference of importance, as some species are very small and others conspicuous by their size. A dozen of the latter will be of greater influence on the host than a thousand of the minute varieties.

From these tables it appears that on the whole the migrating fishes are more heavily infected than those which are confined to fresh water during their entire existence. This is conspicuously true of the Alaska salmon. In addition to the migratory fish one will pick out from the tables many rapacious species as almost or fully equally infected. Such are the lake trout, whitefish, black bass, rock bass, pike, gar, dogfish (*Amia*), bullhead and some other catfishes, wall-eye, and perch, in which practically every individual was infected. That the degree of infection is clearly related to food and habits of life is evident from an examination of the table (p. 226 and 227) in which the fish are grouped by families. In the families of the catfishes (Siluridae), gars (Lepisosteidae), salmon (Salmonidae), and pikes (Luciidae), infection is almost universally recorded. Among the sunfishes (Centrarchidae) the only exception is the smallest, the common sunfish; among the perches (Percidae), the small darters again are the exceptions. On the other hand the stickleback, miller's thumb and moon-eye are infected in only about half the total cases, while among the cyprinid fishes infection is distinctly unusual. A few types are represented by so few specimens that no conclusions can be legitimately drawn concerning conditions in the family of the species.

Regarding different types of internal parasites the tables disclose some interesting and important conditions. Few fishes shelter equal numbers of all kinds of parasites and no species is recorded as heavily infected with all four groups of intestinal worms. Only one,* the trout of the Great Lakes, is credited with an abundance of three kinds—tapeworms, roundworms and spiny-headed worms; and, strangely, this is almost the only fish listed, and it is the

*The Pacific salmon are all of them well infected by flukes and tapeworms, while some of them, the king coho and red salmon, harbor a generous supply of roundworms also. But, as already remarked, these have brought their parasitic guests with them from the ocean and can hardly be compared justly with fish limited in range to fresh water exclusively.

only member of its family, in which flukes were not found. This is all the more striking in that flukes are abundant in more fish shown in the table than most other types of parasites, being markedly so in fourteen fish listed, as against sixteen records of marked abundance in a given host species for tapeworms, 7 for roundworms and 8 for spiny-headed worms. In the catfishes the only very abundant group of parasites is the flukes and that occurs in extra measure in a single species, while other types of parasites are distinctly infrequent. In this same group of the catfishes, however, very few fish were found to be free from parasites, indicating thus a steady infection but of low rate. On the other hand the sunfishes illustrate an irregular, casual infection, often becoming strikingly large. An inspection of the table for this group shows that most individuals do not shelter any trematodes, but those that do are relatively heavily infected. The frequency of infection in a given host is indicated by a comparison of the number of hosts infected with the number free, and the degree of the infection is shown by the average number of parasites present in those hosts that are infected. Finally the extreme number of any type of parasite found in a single individual is some indication of the possibility of extreme infection. Thus only one steelhead was infected with trematodes but that one sheltered 142 of these parasites; and one bluefin whitefish contained 303 tapeworms. Numerous similar instances occur in the sunfish family, where half or more of the individuals were free from one or more types of parasite and heavily infected with some other parasitic form which in turn was absent in the next fish examined. Among the perches also parasitic invasion was usually very light, but in a few cases distinctly heavy. These as well as other interesting relations appear on examination of the data given.

It is important to call attention to the necessity of care in interpreting the figures found in the table. On the face of the data given there the stickleback was not heavily infected, since one-third of the total number of fish recorded

were free from any parasitic invasion and the average infection was only three worms—one cestode and two nematodes. Yet in comparison with the size and reserve energy of the host the infection was excessive, especially as the single cestode, parasitic in the body cavity, distended the body to an extreme limit. There was in fact at this point and time a virtual epidemic among the sticklebacks and we picked up daily considerable numbers of dead and dying fish at the surface of the water and along the shore.

After having concluded thus a study of general conditions we must also consider the special relations, since not all parasites are of equal importance to the fish or to the fish culturist.

There are no general diseases produced by internal parasitic worms unless general weakness, loss of flesh and of power of growth and reproduction be considered such. The parasites are located in special places and usually produce very definite effects. Nodules on the skin and in the gill filaments are due to small encysted trematodes. Such a species in black bass, pike, sunfish and perch is described by Osborn (1911). Some free trematodes also live on the gills and in the mouth cavity.

In the intestinal canal of fish Hofer records from Europe 49 different types of trematodes, 44 distinct tapeworms and 65 roundworms, and the number has been considerably increased by the studies of recent years. The number reported from North America is difficult to determine exactly, though certainly much smaller. I estimate it to be about half as great, but the reported forms are apparently much fewer than those which are still unreported.

Trematodes occur frequently in the eye of fish in Europe, causing blindness. While infrequent in nature this trouble becomes common at times in fish ponds, not only destroying the eye but being followed by the death of the fish. The cause is found in minute larvæ of certain flukes, which in the adult condition live in water birds.

The cestodes are in general far larger than trematodes and play accordingly a more important rôle. They live in the intestine, in the pyloric appendages, or cæca, or even in the body cavity. One finds them often in such size and numbers that the cavity of the canal appears to be stuffed full and the intestinal wall is markedly distended by their bodies. In such cases the effect of their presence has been noted by many observers in the greatly emaciated body of the fish. The most frequent types of such worms are the Ichthyotæniadæ and the Bothriocephalidæ. An extensive monograph on the former family has been completed by one of my students and is to be published within the year. His preliminary record of the forms discovered has already appeared (La Rue, 1911).

In the body cavity other species of tapeworms are to be found in certain fresh-water fish. Linton has worked out the life history of one such species, *Dibothrium cordiceps*, which occurs in the trout of Yellowstone Lake, and is so abundant that it prevents the use of these fish for food, except by the pelicans that fish there and in return for their labor secure not only a meal of trout but also a good supply of tapeworms. Similar parasites, known as *Ligula*, are found in fish of the carp tribe in Europe and lead to the death of many of their hosts. Another form, *Schistocephalus dimorphus*, occurs frequently in the body cavity of the European stickleback and at times destroys great numbers of these fish. I have myself observed at Loring, Alaska, an epidemic among the sticklebacks which was caused by a tapeworm in the body cavity that belonged to the same or a very closely related species. These forms are, however, generally distributed in this country. Leidy (1855) was the first to report them from the Atlantic coastal region.

Round- or threadworms are the most common parasites of fishes, and in number of species they exceed other internal parasitic worms. One finds them both free in the alimentary canal and encysted in the various organs of the body. They are mostly small and very uniform in appearance. In spite of

their universal presence in fish it appears probable that they are rarely if ever of any marked disadvantage to their hosts. The small encysted forms which appear as knots or coils from one to several millimeters in diameter in the viscera, the lining of the body cavity, or more rarely in the muscles of the fish, are immature stages that are awaiting transfer to some other host to complete their development. The cysts are most abundant in small pan fish though not entirely wanting in the largest predatory fish.

These encysted worms have been reported often from market fish, as by Leidy (1878) in the shad. While they detract from the appearance of the flesh and interfere with ready sale, they are not harmful to the fish and do not injure its food value.

The larger predatory fish contain more frequently the adult stages of these worms as parasites free in the body cavity or the intestine. Only rarely are the parasites abundant enough to exercise any detrimental influence on the activity or health of the fish. When smaller fish become heavily infected, however, the draft on their energy may be sufficient to produce serious consequences. I have observed a heavy mortality among small fish, especially the stickleback, which was clearly due to parasitism by a nematode, from one to several specimens of which were found coiled up in the body cavity. The total mass of the parasites equalled or approached that of the fish. In large fish the number of such parasites which may be present without exercising any apparent effect on the welfare of the host is often astonishing.

The *Acanthocephala* are roundworms that possess a proboscis covered with hooks which they drive into the wall of the intestine and thus maintain their hold. They are present at times in very large numbers so that they almost occlude the lumen of the canal and the wall is badly distorted by the numerous proboscides driven into it. At times they bore their way through the wall into the body cavity. Perhaps by virtue of their ability to make wounds in the

tissue they give rise to troubles of a serious type. At all events extensive fatal epidemics among fish, both in fish ponds and in nature, have been traced to their presence. I do not find that in this country any such direct association has yet been determined, but I have seen many instances in which they had caused serious injuries and the tables show that they are subject to most striking variations in number in individual cases.

One finds leeches often on the skin of fishes and in some cases the number is sufficient to be injurious to the fish. Lake trout and whitefish are not infrequently taken with large numbers of these worms on the surface of the body.

The crustacea are as characteristic external parasites as are the worms internal parasites. Numerous types of this great group are familiar to the fish culturist. The flattened scale-like fish lice, or Argulidae, occur on fresh-water fish. In France at least they have been shown to be the cause of great damage to fish in artificial ponds, where they increase more easily than in nature. Thus far no effective means of disposing of them have been discovered. The numbers of such forms may be reduced to the minimum by keeping surface-feeding fish in the fish ponds, since the young forms of the parasites are free-living surface swimmers and are eagerly sought out and devoured by plankton-feeding fish.

The parasitic Copepoda, or Siphonostoma, are sometimes found on the skin but more frequently attached to the gill bars or gill covers inside the gill chamber. They present in the full grown condition an irregular, shapeless appearance that renders it difficult to recognize their close relationship to the group of free-living Copepoda which forms so important an element in the food of fishes. They are not so numerous in fresh-water fish as in the marine species and when the number of these ectoparasites found on a single host is not large, they are probably of little influence on it. Any considerable increase in numbers is accompanied by the death of the infected fish.

The external crustaceous parasites of fish can all be easily and readily determined by reference to the splendid series of recent studies on this group by C. B. Wilson. As the older accounts are important on account of their data concerning effects on fish they also are given in the list of papers although they contain imperfect and sometimes erroneous statements concerning the parasite and in all cases reference should also be made to the later papers by Wilson. Especial mention should be made of two papers (Wilson, 1902 and 1911b), which contain very complete synopses of the fish lice and the most frequent gill parasites and hence are of special value to the fish culturist seeking knowledge concerning forms of these types. Reference to the original papers is necessary if it is desired to determine accurately the species present. Even in such thoroughly studied groups it is too much to expect that the record is complete or that no other species than those listed are to be found on our fresh-water fish. The young of these species are free-swimming and seek out new hosts by active migration through the water. It is clear then, that small active plankton-feeding fish will tend to keep down the number of these parasites by destroying the young during this active stage.

SCIENTIFIC NAME	COMMON NAME	TOTAL INFECTION				TREMATODE INFECTION	CESTODE INFECTION	NEMATODE INFECTION	ACANTHOCEPHALA INFECTION
		No. fish infected.	No. free from parasites.	Total no. fish examined.	Average no. parasites per fish.				
<i>Acipenseridae</i> —									
<i>Acipenser</i>	Lake sturgeon	2	85	43	38	2	2	5	3
<i>Leptocephala</i> —									
<i>Leptocephalus</i>	Long-nosed gar	3	1	5	3	1	1	2	4
<i>Lepisosteus osseus</i> (Linnaeus)	Short-nosed gar	9	336	37	148	30	127	20	48
<i>Lepisosteus platostomus</i> Rafinesque		0	0	0	0	0	0	0	0
<i>Amiidae</i> —									
<i>Amia calva</i> Linnaeus	Dogfish, bowfin	27	32	4236	16	3789	11	315	15
<i>Amia</i>	Channel cat	6	69	10	3	11	2	6	5
<i>Siluridae</i> —									
<i>Ictalurus punctatus</i> (Rafinesque)	Horned pout	1	15	126	9	8	70	10	13
<i>Ameiurus nebulosus</i> (LeSueur)	Black bullhead	14	1	120	120	1	1	1	1
<i>Ameiurus melas</i> (Rafinesque)		3	3	3	1	1	1	1	1
<i>Schilbeidae</i> —									
<i>Catostomus</i>	Small-mouthed buffalo	17	17	569	33	12	16	3	1
<i>Ictalobus bubalus</i> (Rafinesque)	Carp sucker	13	2	15	266	20	5	54	9
<i>Cariodides carpio</i> (Rafinesque)	Quillback	1	6	474	79	5	5	2	80
<i>Cariodides velifer</i> (Rafinesque)	Sucker	6	4	4	4	4	4	4	4
<i>Catostomus commersoni</i> (Lacépède)	Chub sucker	19	4	23	624	33	20	13	19
<i>Epiplatys</i>	Red horse	3	3	3	3	3	3	3	3
<i>Moxostoma auroleum</i> (LeSueur)		3	3	3	3	3	3	3	3
<i>Cyprinidae</i> —									
<i>Cyprinus carpio</i> Linnaeus	German carp	3	10	6	2	10	10	10	10
<i>Cyprinus anomalum</i> (Rafinesque)	Stone roller	3	3	3	3	3	3	3	3
<i>Camptostoma anomalum</i> (Rafinesque)	Blunt-nosed minnow	5	5	5	5	5	5	5	5
<i>Pimephales notatus</i> (Mitchill)	Silver chub	5	5	5	5	5	5	5	5
<i>Semotilus atropurpureus</i> (Girard)	Straw-colored minnow	5	5	5	5	5	5	5	5
<i>Nottropis shufhardi</i> (Girard)		5	5	5	5	5	5	5	5
<i>Epiplatys</i>		5	5	5	5	5	5	5	5
<i>Phenacobius mirabilis</i> (Girard)		5	5	5	5	5	5	5	5
<i>Anguilla</i> —									
<i>Anguilla chrisypsa</i> Rafinesque	American eel	0	11	254	28	3	217	27	5

Hiodontidae—	7	6	13	644	92	7	475	79	10	22	7	145	24	12	2	2
Hiodon tergisus LeSueur	7	6	13	644	92	7	475	79	10	22	7	145	24	12	2	2
Dorosomidae—																
Dorosoma cepedianum (LeSueur)	2	2	4	2	1	4	.....	.....	3	1	1	4	.....	3	1	1
Salmonidae—																
Coregonus clupeaformis Richardson	17	.....	17	1,174	69	17	.....	1	16	2	17	.....	.....	1	.....	.....
Coregonus alpestris (Mitchill)	1	.....	1	53	53	1	.....	.....	.....	13	13	.....	20	20	69	69
Argyrosomus artedii (LeSueur)	3	.....	3	33	11	3	.....	.....	1	26	13	.....	2	2	7	7
Argyrosomus prognathus (H. M. Smith)	1	.....	1	307	307	1	.....	.....	.....	303	303	.....	.....	.....	4	4
Argyrosomus nigripinnis Gill	75	.....	75	8,545	114	10	2,972	46	5,101	73	21	439	7	67	33	33
Oncorhynchus gorbuscha (Walbaum)	32	.....	32	3,310	103	2	2,459	81	12	859	28	21	30	29	22	22
Oncorhynchus tshawytscha (Walbaum)	35	.....	35	4,458	103	3	3,854	66	12	1,662	12	19	40	10	57	57
Oncorhynchus nerka (Walbaum)	20	.....	20	8,423	35	11	3,570	26	57	3275	13	20	3,570	11	333	69
Oncorhynchus tshawytscha (Walbaum)	13	.....	13	5,238	41	15	159	6	8	474	47	15	7	27	28	28
Salmo gairdneri Richardson	10	.....	10	2,225	22	9	142	2	43	5	.....	40	4	10	.....	.....
Salmo gairdneri Richardson	10	.....	10	2,225	22	9	142	2	43	5	.....	40	4	10	.....	.....
Salmo irideus Gibbons	2	.....	2	30	15	.....	28	14	2	.....	1	2	2	2	.....	.....
Cristivomer namaycush (Walbaum)	10	.....	10	10,035	103	10	.....	.....	3	448	64	5	349	70	6	238
Salvelinus namaycush (Walbaum)	20	.....	20	22,171	59	4	1,054	59	10	59	5	13	41	5	16	17
Salvelinus namaycush (Walbaum)	20	.....	20	22,171	59	4	1,054	59	10	59	5	13	41	5	16	17
Argentinidae—																
Argentinus mordax (Mitchill)	50	8	58	270	5	10	169	4	17	101	2	58	.....	58	.....	.....
Leptocottidae—																
Leptocottus armatus LeSueur	13	.....	13	104	9	2	65	6	2	39	4	12	.....	12	8	8
Esox lucius Linnaeus	3	.....	3	24	8	2	8	8	1	8	4	3	.....	.....	.....	.....
Esox masquinongy Mitchill	1	.....	1	15	15	.....	15	15	1	.....	.....	1	.....	.....	.....	.....
Gasterosteidae—																
Gasterosteus williamsoni Girard	37	19	56	94	3	56	.....	.....	43	16	1	27	75	3	54	5
Centrarchidae—																
Pomoxis sparoides (Lacépède)	10	2	12	88	9	10	51	26	11	3	3	6	15	3	5	19
Ambloplites rupestris (Rafinesque)	31	.....	31	481	16	27	75	19	20	13	1	10	28	18	1	358
Lepomis palustris (Mitchill)	6	1	7	348	55	17	9	3	13	2	1	8	17	1	11	12
Epiplatys spilargenteus (Lacépède)	8	.....	8	1,818	87	24	931	45	27	146	8	38	18	3	14	2703
Micropterus dolomieu Lacépède	44	1	45	1,818	87	24	931	45	27	146	8	38	18	3	14	2703
Micropterus salmoides (Lacépède)	2	.....	2	149	75	1	123	123	.....	3	2	2	.....	.....	23	12
Percidae—																
Stizostedion vitreum (Mitchill)	18	.....	18	478	27	12	6	1	10	139	17	18	.....	7	333	30
Stizostedion canadense (Smith)	7	.....	7	316	45	6	1	1	1	313	55	7	.....	7	333	30
Perca flavescens (Mitchill)	39	1	40	202	5	35	11	2	9	48	1	21	136	7	9	7
Hadropeterson aspro (Cope & Jordan)	2	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Diplosion biennis (Rafinesque)	3	.....	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Etheostoma caeruleum Storer	4	.....	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Scomberomorus regalis (Rafinesque)	12	1	13	298	25	1	295	25	11	2	1	12	1	1	13	.....
Roccus chrysops (Rafinesque)	14	.....	14	145	10	.....	131	9	13	4	1	12	10	5	14	.....
Aplocheilichthys grunniens Rafinesque	21	24	45	183	9	44	20	20	30	130	9	41	33	8	45	.....
Cottidae—																
Cottus bairdii (Rafinesque)	3	3	247	82	1	11	6	56	19	3	1	180	90
Gadidae—																
Lota maculosa (LeSueur)	3	3	247	82	1	11	6	56	19	3	1	180	90

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ATKINS, CHARLES G.

1901. The study of fish diseases. Transactions American Fisheries Society, 30th meeting, p. 82-89.

Records, among thirteen diseases affecting salmon and trout, heavy mortality among young lake trout due to *Gyrodactylus elegans*. Remedy by bath of one part cider vinegar with three parts water.

BEAN, TARLETON H.

1891. Report on the salmon and salmon rivers of Alaska, with notes on the conditions, methods and needs of the salmon fisheries. Bulletin U. S. Fish Commission, vol. ix, 1889, p. 165-208.

Notes numerous intestinal worms in red salmon; parasitic copepods on all species of salmon. A disease among rainbow trout which has caused great mortality is probably due to encysted parasites, chiefly in the kidneys, but also in liver and spleen. Dolly Varden trout taken at Karluk Lake, nearly dead, had the mouth full of large lernæan parasites.

1894. Life history of the salmon. Ibid., vol. xii, 1892. p. 21-38.

Data on parasites same as in Bean, 1891.

- 1907a. Some practical difficulties in the way of fish culture. Transactions American Fisheries Society, 36th meeting, p. 184-192.

Notes eye disease of young trout as a new bacterial disease, not to be confused with pop-eye, a parasitic disease. Also the gill louse so fatal to trout 2 or 3 years' old.

- 1907b. Report of State Fish Culturist for the year 1906. Twelfth Annual Report New York Forest, Fish and Game Commission, p. 129-130, 131-142. (In report for 1904-5-6, p. 177-231.)

At the Adirondack hatchery a gill parasite is very injurious to trout, especially those of one and two years, and older. The only check is the introduction of a surface feeding fish to consume the swimming larvæ of the parasite. The waters of Spring Creek are so badly infected that it is no longer possible to rear brook trout in ponds fed by this stream. The parasite was identified as *Lernæopoda salmonæ*. It does not attack brown trout or rainbow trout. In black bass larval cestodes are sometimes abundant, but are not known to influence the fish unfavorably.

The extensive section on fish diseases is a translation in part of Hofer, 1904 (q. v.).

1908. Report of the State Fish Culturist. Ibid., 13th report, p. 1-63.

Parasite (*Filaria rubra* Leidy) found in intestine of catfish in Hackensack River. Also occurs in eels and sunfish in that region.

- 1910a. Notes on New York fishes. Ibid., 14th report, p. 192-228.

Notes a larval worm (nematode?) in eruptions on the skin of the eel, others in the skin of black bass (determined as nematode by Dr. Linton). Encysted distomes in the skin of yellow perch were also determined by Linton provisionally as distomes in larval stages. The adult *Diplostomum* occurs in fish-eating birds.

- 1910b. A plea for the systematic study of fish diseases. Transactions American Fisheries Society, 39th meeting, p. 65-73.

Emphasizes the importance of the subject, and scanty knowledge to date. Gives bibliography with reviews of most important papers.

1911. Notes on black bass. Ibid., 40th meeting, p. 123-128.

Notes on the occurrence of various parasites in food fishes in New York hatcheries and aquaria. Records the occurrence of both nematodes and trematodes in the eyes in cases examined.

BENEDICT, H. M.

1900. On the structure of two fish tapeworms from the genus *Proteocephalus*, Weinland 1858. *Journal of Morphology*, vol. xvi, p. 337-368, 1 pl.

Detailed study of *Proteocephalus ambloplitis* (Leidy) from black bass and *P. ocellatus* (Rud) from whitefish. The material was taken from a collection made at Lake St. Clair (cf. Ward, 1894c). The species studied were recently determined by La Rue (1911) as *Proteocephalus exiguus* n. sp. and *P. ambloplitis* (Leidy).

CALKINS, G. N.

1899. Report upon the recent epidemic among brook trout. Fourth Report New York Forest, Fish and Game Commission, p. 175-190.

The epidemic, equally fatal to fish of all ages, is characterized by deep ulcers. It is caused by a sporozoan parasite, *Lymphosporidium truttae*, which is fully described in its various stages. Every fish at this trout farm succumbed to this disease.

- 1900a. *Lymphosporidium truttae*, nov. gen. nov. spec., the cause of a recent brook trout epidemic. *Science*, n. s., vol. xii, no. 306, p. 64-65.

Summary of report on epidemic, giving also main facts in structure and life history of causal organism.

- 1900b. *Lymphosporidium truttae*, nov. gen. nov. sp., the cause of a recent epidemic among brook trout, *Salvelinus fontinalis*. *Zoologischer Anzeiger*, bd. xxiii, p. 513-520, 6 fig.

Extended account of the parasite and of the epidemic. The stages in the life history of the organism are described carefully and the possible relationship to other groups of Sporozoa discussed. Since the organism was not discovered until the fish had perished, both the origin of the disease and the remedy remain undetermined.

- 1900c. *Lymphosporidium truttae*, nov. gen. nov. sp., the cause of a recent epidemic among brook trout. *Proceedings American Association for the Advancement of Science*, 49th meeting, p. 238-239.

Brief extract.

CONNER, CHARLES H.

1905. *Glochidia of Unio on fishes*. *Nautilus*, vol. xviii, p. 142-143.
On anal and caudal fins of sunfish.

DANA, J. D., and HERRICK, E. C.

1837. Description of the *Argulus Catastomi*, a new parasitic crustaceous animal (with figures). *American Journal of Science*, vol. xxxi, p. 297-308.

Found on operculum within the branchial chamber of the sucker in Mill River.

DUNNING, PHILO, AND OTHERS.

1884. Two hundred tons of dead fish, mostly perch, at Lake Mendota, Wisconsin. *Bulletin U. S. Fish Commission*, vol. iv, 1884, p. 439-443.

Theory that the epidemic was due to a parasite (leech?) eaten by the perch. Another view that the cause is a parasite feeding upon the gills. [Neither of these views was substantiated by later investigations; see Forbes, 1890.]

EGGELING, O., AND EHRENBERG, FR.

1908. The fresh-water aquarium and its inhabitants. 352 p., illus. New York.

Discusses briefly many forms of animal parasites found on fishes. Notes their rapid increase and hence more serious character in the narrow limits of the aquarium.

FELLOWS, C. S.

1888. A description of *Ergasilus chautauquaensis*, a new species of Copepoda, and a list of other Entomostraca found at Lake Chautauqua in August, 1886. *Proceedings American Society of Microscopists*, vol. ix, p. 246-249.

First note on this common parasitic species of which the host is even yet unknown.

FORBES, S. A.

1890. Preliminary report upon the invertebrate animals inhabiting Lakes Geneva and Mendota, Wisconsin, with an account of the fish epidemic in Lake Mendota in 1884. *Bulletin U. S. Fish Commission*, vol. viii, 1888, p. 473-487.

Disproves parasitic theory of epidemic.

1894. The aquarium of the United States Fish Commission at the World's Columbian Exposition. *Ibid.*, vol. xiii, 1893, p. 143-158.

Young catfish (*Ameiurus albidus*) from the Potomac River were attacked by a skin disease. The skin was covered with minute white specks; the fish ceased to feed and began to die; due to *Ichthyophthirius*, recorded as an aquarium parasite especially destructive to young trout in Europe. Further study of the disease assigned to Dr. C. W. Stiles (cf. Stiles, 1894).

GAGE, S. H.

1893. The lake and brook lampreys of New York, especially those of Cayuga and Seneca Lakes. *Wilder Quarter-Century Book*, p. 421-492, 8 pl.

The lake lamprey is wholly parasitic during its adult life. From the economic standpoint the destruction of lampreys is desirable and can be accomplished when they congregate to ascend the tributaries for spawning.

1898. Transformation of the brook lamprey (*Lampetra wilderi*) and parasitism among lampreys. *Proceedings American Association for the Advancement of Science*, 47th meeting, p. 372-373.

While the lake lamprey is exclusively parasitic, the brook lamprey has no parasitic life.

GOLDBERGER, JOSEPH.

1911. Some known and three new endoparasitic trematodes from American fresh-water fish. *Bulletin Hygienic Laboratory, U. S. Public Health and Marine-Hospital Service*, no. 71, 35 p., 5 pl.

Discusses *Leuceruthrus micropteri* from black bass and bowfin, *Azygia loossii* (cf. Marshall & Gilbert, 1905b), *A. acuminata* from bowfin, *A. bulbosa* from the same host, and also *Hassallius hassalli* from rock bass.

GRAYBILL, H. W.

1902. Some points in the structure of the Acanthocephala. *Transactions American Microscopical Society*, vol. xxiii, p. 191-200.

The parasites were collected from the rock bass and the black bass in the Great Lakes.

GURLEY, R. R.

1893. On the classification of the Myxosporidia, a group of protozoan parasites infesting fishes. *Bulletin U. S. Fish Commission*, vol. xi, 1891, p. 407-420.

Preliminary report dealing especially with the classification of these parasites.

GURLEY, R. R.—Continued.

1894. The Myxosporidia, or psorosperms of fishes, and the epidemics produced by them. Report U. S. Fish Commission, 1892, p. 65-304, 47 pl.

Monographic account of these parasites. Effects, epidemics, structure, classification and records of occurrence. From fresh water in North America 6 species are recorded, viz: *Myxobolus monurus* in pirate perch; *M. transvalis* in shiner; *M. oblongus* and *M. globosus* in sucker; *M. macrurus* in a minnow; *M. linearis* in the bullhead, and an unidentified species in a minnow. This list is exceedingly incomplete as these forms have not been studied extensively.

HOFER, B.

1904. Handbuch der Fischkrankheiten, 384 p., 18 pl. color. Munich.

Abstracted in Bean, 1910. Translations of some sections are given by Bean, 1907.

KELLCOTT, D. S.

1877. Description of a new species of *Argulus*. Bulletin Buffalo Society of Natural Sciences, vol. III, p. 214-216, 1 pl.

From the gar pike taken in the Niagara River near Buffalo; named *Argulus lepidostei*. Fastened near pectoral fins or in gill cavity.

1880. *Argulus stizostethii*, n. sp. American Journal of Microscopy and Popular Science, vol. v, p. 53.

Description with figures of species from blue pike; the larva of this parasite has been described elsewhere by the same author (cf. Wilson, 1902, p. 640, 713).

1886. A note on *Argulus catastomi*. Proceedings American Society Microscopists, vol. VIII, p. 144.

Reports this species of fish louse from suckers in Cayuga Lake.

KERBERT, C.

1886. *Chromatophagus parasiticus*—a contribution to the natural history of parasites. Report U. S. Fish Commission, 1884, p. 1127-1136. Translated from the German.

Full description of dangerous skin parasite producing epidemics in fresh-water fishes held in aquaria. Same species later studied in this country by Stiles, 1894 (q. v.).

LA RUE, G. R.

1911. A revision of the cestode family Proteocephalidae. Zoologischer Anzeiger, bd. XXXVIII, p. 473-482.

Preliminary report on the most abundant type of fish tapeworms with descriptions of each species, including three new genera and nine new species. Many old forms are accurately described for the first time.

LEFEVRE, G., and CURTIS, W. C.

1910. Reproduction and parasitism in the Unionidae. Journal of Experimental Zoology, vol. IX, p. 79-115, 5 pl.

Infections observed in nature during November. Roach, carp, perch, bluegill, rock bass and crappie. Only 1 to 20 glochidia on each fish. Artificial infection far greater in extent. Under natural conditions maximum infections never obtain.

LEIDY, JOSEPH.

1851. Contributions to helminthology. Proceedings Academy Natural Sciences, Philadelphia, vol. v, p. 205-210.

Records *Distomum longum* and *D. tereticolle* from pike; *Echinorhynchus lateralis* from brook trout; *E. proteus* from white bass.

1853. On nodular bodies embedded in the tail and fins of fishes, a parasitic worm of the genus *Distoma*. Ibid., vol. VI, p. 433.

Brief record of specimen.

LEIDY, JOSEPH—Continued.

1855. Notices on some tapeworms. *Ibid.*, vol. VII, p. 43.
Records *Ligula monogramma* from chub.
1856. A synopsis of Entozoa and some of their ectocongeners, observed by the author. *Ibid.*, vol. VIII, p. 42-58.
Records *Clinostomum gracile* from pike and larva encysted in sunfish which latter harbors also *Diplostomum*; *Filaria rubra* from white bass; *F. quadrilobulata* from the eel.
1871. Notice of some worms, *Dibothrium cordiceps*, *Hirudo*, *Gordius*. *Ibid.*, vol. XXIII, p. 305-307.
Describes specimens of trout from Yellowstone River infested with tapeworm *Dibothrium cordiceps*. Species studied later by Linton, 1891a.
1875. On psorosperms in a mallard duck. *Ibid.*, vol. XXVII, p. 126-127.
Infection may have come from infected fish.
1878. On parasitic worms in the shad (*Filaria capsularia*). *Ibid.*, vol. XXX, p. 171.
Description of cysts of *Agammonema capsularia* from shad and herring; often very numerous. Does not affect fish or render it unwholesome as food.
1882. *Filaria* of the black bass. *Ibid.*, vol. XXXIV, p. 69.
Encysted red worms sometimes very common. Described but not determined.
1885. *Bothriocephalus* in trout. *Ibid.*, vol. XXXVII, p. 122-123.
Record of specimens taken from trout. Brief description of form named *B. cestus*.
- 1886a. On *Amia* and its probable *Tænia*. *Ibid.*, vol. XXXVIII, p. 62.
Note on the occurrence in the bowfin of a species probably *T. filicollis*.
- 1886b. Notices of nematoid worms. *Ibid.*, vol. XXXVIII, p. 308-313.
Includes description of *Filaria stigmatura* from lake trout.
1887. Notice of some parasitic worms. *Ibid.*, vol. XXXIX, p. 20-24.
Includes description of *Tænia ambloplitis* from rock bass; *T. micropteri* from black bass; *Distomum hispidum* from sturgeon.
- 1888a. Parasites of the pickerel. *Ibid.*, vol. XL, p. 169.
Describes *T. leptosoma* from pike; may be identical with *T. ambloplitis* from rock bass.
- 1888b. Parasites of the striped bass. *Ibid.*, vol. XL, p. 124-125.
Records *Ergasilus labracis* from gills of striped bass and *Echinorhynchus proteus* from intestine. Migratory fish.
- 1888c. Parasites of the rock fish. *Ibid.*, vol. XL, p. 166-168.
In addition to these noted above describes *Distomum galactosomum*, a new species, and *Agammonema capsularia*.
- 1888d. Parasites of the shad and herring. *Journal of Comparative Medicine and Surgery*, vol. IX, p. 211-217.
Migratory fish. Shad from Delaware River harbored *Agammonema capsularia*, *Ascaris adunca*, and *Gymnoscolex picta*. Herring harbor the first and third only.
1890. Notices of Entozoa. *Ibid.*, 1890, p. 410-418.
Describes *Echinorhynchus paucihatus* from black bass; *Tænia nematosoma* from pike.

LINTON, E.

- 1891a. On two species of larval Dibothria from the Yellowstone National Park. Bulletin U. S. Fish Commission, vol. ix, 1889, p. 65-79, pl. XXIII-XXVII.

Describes *Ligula catostomi* from the body cavity of the sucker and records fragments of the same from the stomach of the trout. Also from the abdominal muscles of the trout, *Dibothrium cordiceps*.

- 1891b. Contribution to the life history of *Dibothrium cordiceps*, a parasite infesting the trout of Yellowstone Lake. Ibid., vol. ix, 1889, p. 337-358, pl. CXVII-CXIX.

Describes more fully this species, noted in earlier paper (1891a), giving data on distribution, frequency, and effects on the host. Adult stage found in the white pelican and discussed in detail together with the general problem of parasitism in trout of Yellowstone Lake, the cause, and the remedy.

- 1891c. Notice of the occurrence of protozoan parasites (psorosperms) on cyprinoid fishes in Ohio. Ibid., vol. ix, 1889, p. 359-361.
Description of an undetermined species on several small minnows.

1893. On fish Entozoa from Yellowstone National Park. Report U. S. Fish Commission, 1899-91, p. 545-564, pl. 63-67.

In addition to forms previously described (1891a) *Monobothrium terebrans* from the sucker, and encysted distoma from the chub; *Distomum laureatum* from the trout; *Echinorhynchus globosus* from trout; *E. tuberosus* from sucker and chub; *Dachnitis globosa* from trout and three unidentified nematodes from the same host.

1894. Some observations concerning fish parasites. Bulletin U. S. Fish Commission, vol. xiii, p. 101-112.

Discussion of frequency of parasites, distinctness of host relationships, injurious effects of Entozoa, the remedies for parasitic diseases and the important problems which present themselves to the helminthologist. Many details given concerning parasites of fresh-water fishes.

1897. Notes on cestode parasites of fishes. Proceedings U. S. National Museum, vol. xx, p. 423-456, 8 pl.

Records *Tania salvelini* from lake trout; *T. dilatata* from eel; *T. ocellata* from rock bass; *T. monobothrium hexacotyle* from sucker; *Schistocephalus dimorphus* from blob; *Cyathocephalus truncatus* from whitefish, *Dibothrium hastatum* from paddlefish; *Dibothrium infundibuliforme* from lawyer and lake trout; *Dibothrium ligula* from sucker, smelt, silver minnow, redbin; and other species not from fresh-water fish.

- 1898a. An economical consideration of fish parasites. Bulletin U. S. Fish Commission, vol. xvii, 1897, p. 194-199.

General discussion of relations of parasites to fish culture. Considers also effect of each type of parasite, their frequency and economic importance.

- 1898b. Notes on trematode parasites of fishes. Proceedings U. S. National Museum, vol. xx, p. 507-548, 15 pl.

Records from fresh-water fish: *Diplostomum cuticola* from various sunfish; *Distomum auriculatum* from the lake sturgeon; *D. gracile* from the bluegill; besides others from migratory and marine fishes as well as some unidentified species.

- 1901a. Fish parasites collected at Woods Hole in 1898. Bulletin U. S. Fish Commission, vol. xix, 1899, p. 267-304, pl. 33-43.

Parasites of salt-water fish save only one migrant, eel, which was only very poorly infested.

LINTON, E.—Cont.

- 1901b. Parasites of fishes of the Woods Hole region. *Ibid.*, vol. XIX, 1899, p. 405-492, pl. 1-xxxiv.

Among numerous records of marine fishes are included the following from migratory or strictly fresh-water hosts: *Dacnitis sphaerocephala*, *Nitzschia elegans* from the sturgeon; *Echinorhynchus attenuatus* from the short-nosed sturgeon; *E. globosus*, *E. agilis* from the eel; *Tania dilatata*, *Rhynchobothrium heterospine*, *R. imparispine*, *R. bulbifer*, *Distomum grandiporum*, *D. vitellosum*, *Ascaris* sp. from salmon; *Cuculanus elegans* from brook trout.

MACCALLUM, W. G.

1895. On the anatomy of two distome parasites of fresh-water fish. *Veterinary Magazine*, vol. II, no. 7, 12 p., 8 fig.

Describes *Distomum isoporum*, var. *armatum* from fresh-water drum, bluegill and sturgeon; also *D. lobotes* from eel, perch and wall-eye. Records further *D. nodulosum* from rock bass, eel, sunfish, drum, sturgeon, black bass; and *D. opacum* from eel. All of the parasites noted are flukes.

MARSH, M. C.

1906. The Cold Spring Harbor epidemic among trout. Tenth Annual Report N. Y. Forest, Fish and Game Commission, p. 125-139. (In Report for 1904-5-6, p. 149-161.)

Describes epidemic of 1904 which destroyed most of the adult stock at the station. Regarded as due to *Lymphosporidium trutta* (cf. Calkins, 1900). Advises to avoid overcrowding, to transfer to larger quarters with better flow of water, and to use chloride of lime or sulphate of copper as disinfectant.

MARSHALL, WILLIAM, and GILBERT, N. C.

- 1905a. Notes on the food and parasites of some fresh-water fishes from the lakes at Madison, Wis. Report U. S. Bureau of Fisheries, 1904, p. 513-522.

In the gar were found a few trematodes and cestodes yet unnamed. In the bowfin parasites were very prevalent. The bullhead sheltered prominently cestodes. Parasites were regularly present in the fish examined. The white bass and calico bass had few parasites, and the rock bass sheltered many Acanthocephala. In the large-mouth black bass no individual was free from parasites. Cestodes and Acanthocephala most abundant. Perch are also heavily infected even in winter.

- 1905b. Three new trematodes found principally in black bass. *Zoologische Jahrbücher, Abt. Syst.*, bd. XXII, p. 475-488, 1 taf.

Common in fish from lakes around Madison (Wis.). The species were named *Cacincola parvulus*, *Leucerothrus micropteri* and *Azygia loosii*. The pike and bowfin were also infected with last-named species.

MILNER, J. W.

1874. Report on the fisheries of the Great Lakes, the result of inquiries prosecuted in 1871 and 1872. Report U. S. Commission of Fish and Fisheries, 1872-1873, p. 1-75.

Found in lake trout a few parasites, especially a tapeworm that is very numerous in same. The cisco also carries tapeworms in abundance and a lernæan on the skin. This is parasitic on the whitefish, as are also a leech, *Ichthyobdella punctata* (Smith), and two intestinal parasites, a cestode (?) and an *Echinorhynchus*. The most marked parasite of the lake herring is a larval cestode in the dorsal muscles, common in April but not later than June. It has also intestinal parasites.

NICKERSON, W. S.

1900. Concerning *Cotylogaster occidentalis*. *Science*, n. s., vol. II, p. 250.

Brief abstract of following paper.

NICKERSON, W. S.—Continued.

1902. *Cotylogaster occidentalis* n. sp. and a revision of the family Aspidobothridæ. Zoologische Jahrbücher, Abt. Syst., bd. xv, p. 597-624, 2 taf.
Detailed description of parasite found in sheephead in Minnesota. Systematic outline of this family of flukes.

OSBORN, H. L.

1902. Notes on the trematodes of Lake Chautauqua, N. Y. Science, n. s., vol. xv, p. 573-574.

Records *Microphallus opacus* (Ward) as frequent in black bass, and its larva in crayfishes. *Bunodera* (sp.) occurs also in the black bass. Two other undetermined flukes are found in rock bass, darters and sunfish (cf. following titles for data regarding these parasites).

- 1903a. *Bunodera cornuta* sp. nov., a new parasite from the crayfish and certain fishes of Lake Chautauqua, N. Y. Biological Bulletin, vol. v, p. 63-73, 7 fig.

This parasite occurs in black bass, rock bass and bullheads at Chautauqua Lake, and the young in crayfish there. The structure and life history are described in detail and comparisons made with European species that are closely allied parasites.

- 1903b. On *Cryptogonimus chyli*, n. g., n. sp., a trematode from Lake Chautauqua, N. Y., with novel type of ventral sucker. Science, n. s., vol. xvii, p. 533-534.

Brief description of the structure of a small fluke common in black bass.

- 1903c. On *Cryptogonimus* (n. g.) *chili* (n. sp.), a fluke with two ventral suckers. Zoologischer Anzeiger, bd. xxvi, p. 315-318, 2 fig.

Brief account of a new species of fluke found in black bass.

1910. On the structure of *Cryptogonimus* (nov. gen.) *chyli* (n. sp.), an aberrant distome from fishes of Michigan and New York. Journal of Experimental Zoology, vol. ix, p. 517-536.

Extended account of the structure and relationships of this parasite which occurs in stomach and intestines of black bass and rock bass. It is found in the St. Mary's River and in Chautauqua Lake, also in Canada (Stafford, 1905).

1911. On the distribution and mode of occurrence in the United States and Canada of *Clinostomum marginatum*, a trematode parasite in fish, frogs and birds. Biological Bulletin, vol. xx, p. 350-366.

Full discussion of encysted stages in black bass, perch, sunfish where it occurs in muscle tissue. Adult stage in fish-eating birds.

PRATT, H. S.

1900. Synopsis of North American invertebrates. XII.—The trematodes, part 1, The Heterocotylea or monogenetic forms. American Naturalist, vol. xxxiv, p. 645-662.

Systematic topography; figures of each species.

1902. Synopsis of North American invertebrates. XII.—Trematodes, part 2, The Aspidocotylea and the Malacotylea, or digenetic forms. Ibid., vol. xxxvi, p. 887-910, 953-971, 130 fig.

Systematic synopsis; key, description of all species, figures of most. Bibliography.

RATHBUN, RICHARD.

1885. Annotated list of the described species of parasitic Copepoda (Siphonostomata) from American waters contained in the National Museum. Proceedings U. S. National Museum, vol. VII, p. 483-492.

Few species on migratory fishes, Atlantic and Pacific salmon, eel, sturgeon; also one species, *Lernaeopoda coregoni* (Smith) from the whitefish in Lake Superior.

RUTTER, CLOUDSLEY.

1903. Natural history of the quinnat salmon. A report of investigations in the Sacramento River 1896-1901. Bulletin U. S. Fish Commission, vol. XXII, 1902, p. 65-141.

Records gastric parasites in young salmon, 15 per cent being infected on the average. "It is evident that residence in fresh water is conducive to the growth of parasites in the stomachs of young salmon." In spawning salmon, intestinal parasites frequent. Another common pest of the salmon in fresh water is a parasitic copepod which attaches itself to gill filaments. There are not usually very many on one fish, but sometimes the gills are almost destroyed by them." (See plates 13 and 15.)

RYDER, J. A.

1880. The psorosperms found in *Aphredoderus sayanus*. American Naturalist, vol. XIV, p. 211-212, 2 pl.

Encysted in subcutaneous intermuscular tissue of pirate perch from Woodbury, N. J. According to prevalent view regarded as young of *Gregarina*, now known to belong to *Myxosporidia*. This species named *Myxobolus monurus* by Gurley, 1893.

SEAL, WM. P.

1889. The aquarium; a brief exposition of its principles and management. Bulletin U. S. Fish Commission, vol. VII, 1887, p. 274-282.

Fish are sometimes infested with parasites, some of them microscopic and of serious effect. But little is known of fish diseases.

1892. Observations on the aquaria of the U. S. Fish Commission at Central Station, Washington, D. C. Bulletin U. S. Fish Commission, vol. X, 1890, p. 1-12, pl. 1-4.

Goldfish and carp frequently infected by minute infusorian not determined; catfish, sunfish, white perch, trout and others infested in winter by *Chromatophagus parasiticus* (*Ichthyophthirius*). All have yielded to brackish water treatment. Parasite most persistent and troublesome in fresh-water aquaria. Few fresh-water fish free from its ravages.

SMITH, EUGENE.

1902. The home aquarium, p. 182-183. New York.

Parasitic diseases offer a wide field for investigation. Remove diseased individuals. An aquarium once infected is difficult to clear of parasites.

SMITH, S. I.

1874. The Crustacea of the fresh waters of the United States Report U. S. Commission of Fish and Fisheries 1872-73, p. 638-665.

Synopsis of the parasitic Crustacea on United States fresh-water fishes. Lists *Argulus catostomi* on sucker, *Lepeophtheirus salmonis* on salmon, *Actinocyclus pimelodi* on channel cat, *Lernaeopoda fontinalis* on brook trout, apparently the cause of the death of these fish, *L. siscoeae* on lake trout, *L. coregoni* on whitefish, *Cauloxenus stygius* on blind fish, *Lernaeocera cruciata* on rock bass and *L. catostomi* on the large-scaled redbreast.

STAFFORD, J.

1902. Notes on worms. Zoologischer Anzeiger, bd. xxv, p. 481-483.

Records *Spathidium folium* (von Olfers) from common bullhead, *Bunodera nodulosa* (Zeder) from brook trout, *Creadium isoporum* (Looss) from chub; they "differ in some respects from the European forms." Other undetermined species noted.

1904. Trematodes from Canadian fishes. Ibid., bd. xxvii, p. 481-495.

Records several species from migratory fishes, localities not given; also *Diplobothrium armatum* (F. S. Leuckart) from lake sturgeon; *Megadistomum longum* (Leidy) from muskallunge; *Asigia tereticolle* (Rudolph) [error, see Ward, 1910] from pike, lawyer and great catfish; *Mimodistomum angusticaudum* from lawyer and wall-eye; *Bunodera nodulosa* (Zeder) from perch; *Crepidostomum laureatum* (Zeder) from brook trout; *Crepidostomum cornutum* Osborn from rock bass; *Acrodactyla petalosa* Lander from lake sturgeon; *Phyllodistomum folium* (von Olfers) from pike; *Phyllodistomum superbum* from common bullhead and perch; *Deropristis hispidus* (Abil.) from lake sturgeon; *Centrovarium labotes* (MacCallum) from pike and wall-eye; *Clinostomum gracile* Leidy from perch; *Allocreadium isoporum* Looss from chub; *Plagioporus serotinus* from large-scaled sucker; *Protenteron diphanum* from rock bass; *Diplostomum cuticola* (Dies.) from rock bass; *Diplostomum parvulum* from chub and pike; *Gasterostomum pusillum* from wall-eye; *Monostomum amiuri* from common bullhead.

1905. Trematodes from Canadian vertebrates. Ibid., bd. xxviii, p. 681-694.

Records *Tetraonchus unguiculatus* Wag. from rock bass and common sunfish; *Cryptogonimus chyli* Osborn from rock bass.

STILES, C. W.

1894. Report on a parasitic protozoan observed on fish in the aquarium. Bulletin U. S. Fish Commission, vol. xiii, 1893, p. 173-190, pl. 11-12.

Extended study of epidemic reported by S. A. Forbes (1894). Careful description of parasite and of lesions produced by it. The form is *Ichthyophthirius multifiliis*. The most practical method of destroying the parasite is to attack it during the free stage period or subsequent to encystment or during the encysted stage, which lasts from one to four days. Salts in the bottom of the aquarium and a very weak solution of methylen blue and eosin gave good results. The reduction of the temperature of the water was followed by a cessation of the epidemic.

STILES, C. W., and HASSALL, A.

1894. A preliminary catalogue of the parasites contained in the collections of the U. S. Bureau of Animal Industry, U. S. Army Medical Museum, Biological Department of the University of Pennsylvania (Coll. Leidy and in Coll. Stiles and Coll. Hassall). Veterinary Magazine, vol. ii, p. 245-354.

Lists among others parasites from fresh-water fishes.

- 1902-1911. Index-catalogue of medical and veterinary zoology. Bulletin Bureau Animal Industry, no. 39, U. S. Department of Agriculture. (Authors, parts 1-35.)

Extremely valuable and very complete list of all papers on animal parasites. Includes papers on fish parasites and on American fresh-water species among others. Author list just completed. Subject indices to follow.

SURFACE, H. A.

- 1898a. Removal of lampreys from the interior waters of New York. Fourth Annual Report New York Forest, Fish and Game Commission, p. 191-245.

The lamprey is one of the most serious enemies of fresh-water fish; it attacks thirty species or more, including the most valuable. The life-history of the lamprey is discussed in detail and measures are proposed for exterminating this species.

SURFACE, H. A.—Continued.

- 1898b. The lampreys of central New York. Bulletin U. S. Fish Commission, vol. xvii, p. 209-215, pl. 10-11.

Description of habits of lampreys and of loss to fish by their attacks. Method for their elimination from waters of New York State.

VERRILL, A. E.

1873. Report upon the invertebrate animals of Vineyard Sound and the adjacent waters, with an account of the physical characteristics of the region. Report U. S. Commission of Fish and Fisheries, 1871-72, p. 295-778.

Mentions the occurrence of parasites on both fresh- and salt-water fishes. Details given refer to salt-water species.

1874. Synopsis of the North American fresh-water leeches. Report U. S. Fish Commission 1872-1873, p. 666-689.

Outlines effects of leeches on fish. The large blood-sucking leeches attack fishes directly, even fishes of considerable size, and destroy them very quickly by sucking their blood; other species are true parasites of fishes and often, when numerous, do them much injury. Still others destroy the food of fishes. Lists the species then known.

WARD, H. B.

- 1894a. On the parasites of the lake fish. I.—Notes on the structure and life-history of *Distoma opacum*, n. sp. Proceedings American Microscopical Society, vol. xv, p. 173-182, 1 pl.

A species abundant in the bowfin, occurring also in the white catfish and the perch. The young form is found encysted in crayfish.

- 1894b. Some notes on the biological relations of the fish parasites of the Great Lakes. Proceedings Nebraska Academy of Sciences, vol. iv, p. 8-11.

Data identical with those in the following paper.

- 1894c. A preliminary report on the worms (mostly parasitic) collected in Lake St. Clair in the summer of 1893. Bulletin Michigan Fish Commission, no. iv, p. 49.

Record of parasites found in fish of twenty species. The small-mouth black bass was most seriously infected. The data obtained are included in the tables of the present paper.

- 1901a. Notes on the parasites of the lake fish. III.—On the structure of the copulatory organs in *Microphallus* nov. gen. Transactions American Microscopical Society, vol. xxii, p. 175-187, 1 pl.

Further description of parasite first reported in 1894, now included in new genus.

- 1901b. Cestoda. Wood's Reference Handbook of the Medical Science, rev. ed., vol. ii, p. 779-794.

General account of group. Full data regarding human parasites. Limited data on fish parasites, especially *Dibothriocephalus latus* and other forms acquired by man from fish.

- 1903a. Nematoda. Ibid., vol. vi, p. 205-225, fig.

General. Full discussion of human parasites. Few references to parasites of fish, particularly those transmitted to man.

- 1903b. Trematoda. Ibid., vol. vii, p. 860-873, fig.

General. Complete only regarding human parasites. Casual references only to fish parasites.

1905. The relations of animals to disease. Science, n. s., vol. xxii, p. 193-203; also Transactions American Microscopical Society, vol. xxvii, p. 5-20.

Considers the different ways in which animals may spread and cause disease.

WARD, H. B.—Continued.

1907. The influence of parasitism on the host. Science, n. s., vol. xxv, p. 201-218; also in Proceedings American Association for the Advancement of Science, 56th meeting, p. 489-523.

Discussion of the precise influence of parasites on host; summarized in the introduction to this paper. Frequent references to fish. Discusses influence of lamprey, effect of broad fish tapeworm, and other fish parasites.

1908. Some points in the migration of Pacific salmon as shown by its parasites. Transactions American Fisheries Society, 37th meeting, p. 92-100.

Records species present and their probable origin, as well as the effect on them of the trip up fresh-water streams to the spawning grounds.

1909. The influence of hibernation and migration on animal parasites. Proceedings 7th International Zoological Congress, Boston, 12 p.

Compares conditions in marine, migratory and fresh-water fishes, as regards distribution, occurrence and abundance of parasites.

1910. Internal parasites of the Sebago salmon. Bulletin U. S. Bureau of Fisheries, vol. xxviii, 1908, p. 1151-1194.

Records from Sebago salmon *Azygia sebago*, *Abothrium crassum*, *Proteocephalus pusillus*, bothriocephalid larvae and unidentified nematodes. The total number of parasites found is very small; the species are characteristic of fresh water. The paper gives also records of parasites found in the European salmon and compares conditions with those in the Sebago form.

WASHBURN, F. L.

1886. Mortality of fish at Lake Mille Lac, Minn. American Naturalist, vol. xx, p. 896-897.

An annually recurring epidemic in summer which destroys thousands of fish is caused by an external parasite, one of the Siphonostomata; some fish show large eaten patches on the sides and belly. The wall-eye is most seriously affected, but perch, rock bass, black bass, calico bass, crappie, a whitefish, the ling, bowfin, pike and large suckers are also attacked.

WILSON, C. B.

1902. North American parasitic copepods, of the family Argulidae, with a bibliography of the group and a systematic review of all known species. (Paper 1.) Proceedings U. S. National Museum, vol. xxv, p. 635-742, pl. 8-27.

Discusses habits of these ectoparasites. *Argulus catostomi* occurs on the sucker and chub sucker, and will attack sunfish, dace, perch and minnow. *A. versicolor* lives on pickerel, but was raised on redbins. Records epidemics due to these species and experiments in limiting the number of such parasites by introducing surface-feeding fish to prey on the free-swimming larvae. Extended discussion of habits with key to species and descriptions of each. *Argulus lepidostei* from the gar, *A. stizostethii* from blue pike, *A. maculosus* from muskallunge, *A. americanus* from the bowfin, are North America fresh-water species.

1904. A new species of Argulus, with a more complete account of two species already described. (Paper 2.) Ibid., vol. xxvii, p. 627-655, 38 fig.

Detailed description of structure and development of *A. americanus* from the bowfin, *A. versicolor* from pickerel, and *A. trilineata* from goldfish.

WILSON, C. B.—Continued.

1905. The fish parasites of the genus *Argulus* found in the Woods Hole region. Bulletin Bureau Fisheries, vol. xxiv, 1904, p. 115-131, 31 fig.

Refers to fishes, mostly marine, of Woods Hole region. Adds to general data in previous paper description of eggs and larvae of fish lice. As an economic factor argulids are unimportant ordinarily. When fish becomes weak by change from salt to fresh water, by disease, lack of food or rise in temperature, serious results may follow. Discusses epidemics noted in Washburn (1886), Wright (1887).

1907. Additional notes on the development of the Argulidae, with description of a new species. Proceedings U. S. National Museum, vol. xxxii, p. 411-424, 4 pl.

The male of *A. catostomi* is described from the redeye and blackfin suckers; also the larva of *S. maculosus* from the redeye and catfish. *Argulus appendiculosus* is described from the sucker and the development of the genus is discussed.

1908. North American parasitic copepods: A list of those found upon the fishes of the Pacific Coast, with descriptions of new genera and species. Ibid., vol. xxxv, p. 431-481, 17 pl.

Among others from marine fish are noted those from fresh-water fishes: *Lernaopoda extumescens* from humpbacked whitefish; *Achtheres coregoni* from whitefish; *Lepeophtheirus salmonis* from the humpbacked salmon, *Argulus pugettensis* from the coho, *Lepeophtheirus pacificus*, *L. salmonis*, *Lernaopoda californiensis*, *L. falcata* from red salmon; *Caligus gurnardi*, *Lepeophtheirus salmonis*, *Lernaopoda beani* from the king salmon; *Lepeophtheirus salmonis*, *Lernaopoda gibber*, *L. bicauculata* from Dolly Varden.

- 1911a. North American parasitic copepods. Part 9, The Lernaopodidae. Ibid., vol. xxxix, p. 189-226.

Full account of the development of *Achtheres ambloplitis*, common on rock bass and occasional on other Centrarchidae. Infection occurs when fish feeding near surface take larvae into mouth and expel them through gills, giving them opportunity to grasp the gill filaments.

- 1911b. North American parasitic copepods belonging to the family Ergasilidae. (Paper 10.) Ibid., vol. xxxix, p. 263-400.

Only one subfamily, Ergasilinae, includes typical fresh-water forms. Common on bass, perch, sunfish, pike, carp; occasional on others. Full description of structure, breeding, development. Key to species and description of each with figures, record of hosts and distribution of parasites.

- 1911c. North American parasitic copepods. Description of new genera and species. (Paper 11.) Ibid., vol. xxxix, p. 625-634, pl. 65-68.

Records and describes *Lernaopoda incermis* from lake herring in Great Lakes.

WRIGHT, R. R.

1879. Contributions to American helminthology. No. 1. Proceedings Canadian Institute, n. s., vol. i, no. 1, 23 p., 2 pl.

Among other parasites from various hosts he records *Clinostomum gracile* in cysts from perch, *Octobothrium sagittatum* from sucker, *Ascaris adumca* from shad, *Ancyracanthus cystidicola* from swim bladder of cisco and *A. serratus* from heart of whitefish.

1882. Notes on American parasitic Copepoda. No. 1. Ibid., vol. i, p. 243-254, 2 pl.

Reports *Ergasilus centrarchidarum* from the gills of perch, sunfish, bream, and particularly the rock bass. Also *Lernaopoda edwardsii* from gills of the brook trout and *Achtheres micropteri* from mouth and gill arches of the small-mouthed black bass. All the fish came from the vicinity of Toronto, Canada.

WRIGHT, R. R.—Continued.

1887. Argulus and mortality of fishes. American Naturalist, vol. XXI, p. 188.

Refers to Washburn (1886) and records fatal epidemic in whitefish of Lake of the Woods due to an undetermined species of *Argulus*, not the same as those from Europe where similar epidemics are not uncommon.

YARROW, H. C.

1874. Notes on the shad as observed at Beaufort Harbor, N. C., and vicinity. Report U. S. Fish Commission 1872-73, p. 453-456.

No disease has ever been noticed prevailing as an epidemic, nor do parasites as a rule infest shad; although occasionally sea lice are found hanging near the gills. They are carried into fresh waters by the migration of the shad.

DISCUSSION

MR. MEEHAN: This is a subject which interests every one of us.

PROF. L. L. DYCHE, Pratt, Kan.: I must express my appreciation of that paper. I shall be glad to see it in print. Most fish culturists know what it is to contend with a great number of diseases that we do not know very much about.

I have only been in this business a short time, but I have had to fight three or four small epidemics already; and not knowing just the nature of these epidemics made it hard to fight them. When we know what the trouble is, we stand a better show to fight it.

This fungus disease is one we do not know how to fight very well. It appears in clear water, cold water and warm water. We find it almost any time of the year in our part of the country. In planning for the new fish hatchery we go above a city, build a dam and get pure fresh water above the place where the city sewage enters the stream. It may be that a certain amount of sewage in water may be good for fish, according to some reports, from a fish food standpoint, but I doubt whether it is good for fish from a parasitic and disease standpoint. The natural process of reasoning would suggest to us that we want pure, clean water to raise fish in. The water supply of the old or present fish hatchery at Pratt, Kan., and that of a number of private ponds along the water course comes from the Ninescah River and from a point below where the city sewage is emptied into the river. This sewage water is from a septic tank system. Yet in the ponds supplied from this water the fish have suffered from repeated attacks of the fungus diseases, and in some instances raw blood-shot places (sores) from the size of a dime to a dollar appeared on the fish, especially affecting the hickory shad and afterward the giant crappie or strawberry bass. At times these affected fish would be seen swimming near the surface of the water and resting near the shore. The dead fish would be found lodged along the shore in different places. The sick and dead fish were most noticeable along the stream and ponds directly receiving water that was affected with the sewage.

Specimens were saved for further study. In one hatchery pond stocked with giant crappie that received water direct from the river supply, twenty-seven spawners died during the spring, and many others seemed to be affected. Almost no young crappie were raised in this pond; however, the goldfish did well in the same pond, apparently not being affected with the fungus. A certain amount of sewage may help to produce food for fish, in one way or another, but on the other hand it may encourage the spread of certain diseases. I am afraid of such water for fish culture purposes.

When this paper on the diseases of fish is published we shall be anxious to read every word of it. It may help us out in certain lines, because fish diseases are appearing in different places in the state of Kansas, and we are continually receiving letters of inquiry in regard to fish that are dying from one or another described or fancied cause; and this is one of the things that has worried me as a fish culturist. After a man has spent considerable money building a pond that may contain several acres of water and has stocked it with fish, he gets nervous and excited as soon as the fish begin to die, and immediately calls upon the fish commissioner for help; and the fish commissioner may not be able to help him, not knowing how to treat or control the disease. A fish culturist is supposed to be a fish doctor.

We are planning to have a building or station costing from \$30,000 to \$50,000 to be used as a laboratory in connection with and on the state hatchery grounds; and people who desire to study fish and subjects connected with the fish culture business will be welcome to come and work in this laboratory. We hope to be able to furnish every advantage possible to such students. This laboratory will be under the direction and in connection with the State University. We hope to be able to help students who may be willing to come and study the diseases affecting the fresh-water fishes, such as we have in Kansas, and which same diseases are troubling fish culturists all over the country.

MR. G. W. N. BROWN, Homer, Minn.: Perhaps I have been more fortunate than most of the members present in having met a man who knew all about fish diseases. While in California I met the superintendent of a state hatchery, who informed me that he had classified 364 different, distinctive fish diseases, almost as many as there are days in the year, and had compounded a remedy for each of these diseases. Unfortunately, however, I did not have the time to take a course in piscatorial medical science. (Laughter.)

DR. TARLETON H. BEAN, Albany, N. Y.: I do not know anything in the course of a long experience in federal and state fish culture that has so much worried me as the one of fish diseases, unless it may be the interjection of politics into fish culture. (Laughter.) I do not know which is worse, for that is a disease also.

MR. D. B. FEARING, Newport, R. I. It is hard to eradicate fungus of that character, I can tell you. (Laughter.)

DR. BEAN: In New York we have had to deal with a great variety of diseases, due not always to bacteria and to larval worms—chiefly though to these sources—as the causes of epidemics; and up to this time we have been unable to utilize to any very great extent the writings of the students of these forms of Protozoa, bacteria and worms, which lie at the root of our troubles. There is only one book so far which the practical fish culturist has been able to consult with any great profit, and that is the little book by Dr. Hofer, which, of course, every advanced student has in his library; and even Dr. Hofer has not gone far enough with his studies. In fact, the Germans who have been so patient in their researches have not gone far enough to lift us out of the hole in which we are floundering. Of course, Dr. Ward knows that better than any one else.

What we have done in New York is this: We have begged the special students to help us, and then have not waited for them to complete their studies; but we have changed our water supply wherever possible, because we realized that these troublesome little animals and plants originate usually in filth due to sewage. At one of the stations of the commission which was put out of business four or five years ago, and had been out of business practically for a great many years prior to that time, we cut out a beautiful little stream because it received drainage from manure heaps and cesspools. It had brought on what we know as the spot disease of the brook trout and the ulcer disease of the brown trout. There did not seem to be anything helpful in literature, and for that reason we cut out the stream entirely, sunk some artesian wells, and fortunately found water at a depth of 19 or 20 feet. We bought some good springs of which we controlled the heads, and since that time the station has become rehabilitated; and whereas it was difficult a few years ago to deliver to the people of New York 200,000 or 300,000 brook trout fingerlings and fry, this year the same station has been troubled to get rid of its surplus of brook trout; and the people who have received the fish have commented on the fact that they are the finest brook trout they have ever seen. It was a very simple process, of course, of a cure. The cause lies in a little creek which flowed through the hatchery ground; but we are not using it now. The same thing was done at Cold Spring Harbor, largely through the help of the Bureau of Fisheries. Messrs. Calkins and Marsh went there and told us what lay at the root of the trouble, and as they could not suggest a cure we changed the water supply there and are now drawing artesian water through three pipes, which furnish quite enough to run the hatchery.

I do not believe that a case of spot disease of the brook trout or ulcer disease of the brown trout has appeared at that hatchery for years. If there is one, I have yet to learn of it.

There is another very troublesome thing at the station in Constantia, on Lake Oneida, which should be carefully studied by bacteriologists and pathologists: I refer to the eye disease of the trout perch, small

yellow perch and black bass. There is a distome which puts its larva into the vitreous humor of the eye of young fish, leading to enormous destruction of young fish of valuable species. For this we know of no remedy at present.

We are told that if we want to be rid of the larval worms we must keep the water birds off the pond; but we cannot keep them off Oneida Lake. The fish run up into the little creeks tributary to Oneida Lake, with the parasite already lodged. So that we are helpless as far as that goes.

I hope the time will come when the bacteriologist can tell us how to combat this distome and other very troublesome and dangerous animal and plant forms, so that we will not have to depend entirely on the change of water supply, because we cannot always do that. Where we have a gravity flow we cannot sink artesian wells in many cases. Massachusetts, Connecticut and Rhode Island—Rhode Island and Massachusetts especially—are so far blest by Nature in this respect that we of New York envy them; and I learn that Pennsylvania also has a feeling of envy toward any state which has artesian water, especially to be had at such moderate depths, which can flow into its troughs and hatcheries; because artesian water properly meandered and brought into the troughs and ponds is the best water in the world; and it is the only water, except pure spring water, which is not always obtainable, upon which we may rely to be rid of these causes of the terrible epidemics which have swept away thousands and tens of thousands of dollars invested in state and governmental work.

TREMATODE PARASITES IN THE SKIN AND FLESH OF FISH AND THE AGENCY OF BIRDS IN THEIR OCCURRENCE

By EDWIN LINTON

In this paper it is my purpose to discuss briefly a few cases of parasitism due to trematodes, confining my remarks to one form which occurs encysted in the flesh of certain fresh-water fishes, and to a few cases of cysts in the skin of fresh-water and of marine fishes.

LIFE-HISTORY OF VERMIAN PARASITES

It is a fact well known to students of zoology, though not so well known to those unlearned in that science, that the group of vermiian parasites belonging to the flatworms makes use of two or more animals in completing the round of life. An animal that acts as a place of lodgment of a parasite is known as a host. In one of these animals the parasite is in the larval stage, in which case the host is said to be intermediate; in the other animal the parasite is mature and produces eggs, its entertainer being then called the final host. There are cases known in which one and the same animal may act as both an intermediate and a final host for the same parasite. In such cases the acquisition of the larval stage of the parasite is accidental and exceptional. Somewhere between the chain of events which links together the various stages in the life-history of any parasitic flatworm an intermediate host, together with its larval parasites enclosed in cysts in its tissues, has been eaten by another animal, usually the final host. And, invariably, as the last link to the chain, the final host has swallowed the larval or immature form which has inhabited one or more intermediate hosts before it has attained its final resting place.

In the order of flatworms known as cestodes or tapeworms, the relation between the intermediate host or hosts and the final host is direct, and may be characterized by the

words eater and eaten. Such, for example, is the relation between the hosts of a small tapeworm (*Otobothrium crenacolle*), which is adult in certain species of shark, and is found encysted in a large number of our bony fishes, notably in the common butterfish (*Poronotus triacanthus*), where it is encysted, sometimes in enormous numbers, in the muscles. (During this past summer I removed 7,932 cysts from the muscles of a single butterfish.) Another, which brings together a bird as the eater and a fish as the eaten, is that of a tapeworm (*Dibothrium cordiceps*), larval in the Rocky Mountain trout and adult in the white pelican.

Indeed, birds and fishes, in the economy of nature, have long been associated as eater and eaten, and it should not be a matter of surprise, therefore, that fishes should be intermediate hosts of many parasites whose development into adult, egg-producing worms depends upon their entering the alimentary canal of some bird.

Not only cestodes, or tapeworms, but trematodes, or flukes, as well, are known which have fishes for their intermediate hosts and birds for their final hosts. The life history of trematodes, however, is more complicated than that of the cestodes, in that an invertebrate, usually a mollusc, serves as one of the intermediate hosts. One of the few examples of trematode life-histories which have been worked out is that one, now become a classic, furnished by the liver fluke of the sheep (*Fasciola hepatica*). It is scarcely possible to give a satisfactory synopsis of this life-history without figures and the use of technical terms. Briefly it is as follows:

The adult flukes live in the biliary ducts of the sheep's liver. The eggs pass readily into the intestine and thence, along with the fæces of their host, to the exterior. Falling in moist places there hatch out from the eggs ciliated embryos of microscopic size, 1/200 of an inch, more or less, in length. They live for a time in the water swimming about actively. Coming in contact with a species of fresh-water snail they enter its pulmonary chamber, where they become fixed, lose

their cilia and are transformed into a more or less irregular mass called a sporocyst. In the interior of a sporocyst there develop, from masses of cells, small worm-like structures provided with a mouth, a pharynx, and a straight intestine. These structures, called rediæ, leave the parent sporocyst and invade the liver of the snail. There they develop further and there is differentiated within them a more or less considerable number of young flukes. These differ from the adult form in the rudimentary character of their reproductive organs and, usually, in having a long tail. They agree with the adult form in having both an oral and ventral sucker and a forked intestine.

These young flukes are called cercariæ. They are exceedingly active, and in form and movement suggest tadpoles. In the tails of cercariæ which I found at Woods Hole this summer (1911) striated muscle fibres were very distinctly shown. Upon escaping from the parent redia the cercaria of the liver fluke lives for a time in water. After it has abandoned its host the cercaria creeps upon the surface of vegetation, where it secretes around itself a transparent cyst, losing its tail during the process of encystment. Sheep or cattle, or, accidentally, man, eating vegetation on which these cysts occur, may thus become the final host in which the young distome develops to maturity after finding its way into the bile ducts of the liver, where it produces eggs, and the round of life is completed.

In passing, it may be worth while to note the enormous number of individual flukes that might develop from a single egg. Thus the egg gives rise to one ciliated larva, and the larva to one sporocyst. The number of rediæ which may develop within a single sporocyst varies considerably within the same species. Furthermore, more than one generation of sporocysts or of rediæ may appear before the cercariæ are produced. On the other hand the redia stage may be omitted altogether. Sporocysts which I have found thus far in marine invertebrates produce cercariæ directly without the intervention of a redia stage, and, in one case, the

cercariae are without tails, thus indicating that they pass to the final host directly when the intermediate host in which they are lodged is swallowed by the proper animal. From 25 to 50 or more cercariae may be counted in sporocysts which I have collected from molluscs and an annelid worm at Woods Hole. If rediae are produced in like numbers in cases where that stage appears, then the number of cercariae which may arise from a single egg might be the last term in a geometrical progression in which the first term is one, the number of terms at least three, and the ratio as much as 50, or even more. This would be interpreted as 1 egg, ciliated larva and sporocyst, 50 rediae, and 2,500 cercariae. In cases where another generation of sporocysts or of rediae appears, another term, or perhaps two would be added to the progression.

A FLESH PARASITE OF THE BLACK BASS AND OTHER FRESH-WATER FISHES

In a recent contribution to the Biological Bulletin (vol. xx, p. 350-366), Prof. H. L. Osborn has brought together the literature on an interesting distome of wide distribution. It has been recorded under a variety of names by different observers but the name which seems to have priority is *Clinostomum marginatum*. This distome has been described and recorded by several observers from a variety of hosts. In the larval or encysted stage it has been reported from the yellow perch, striped bass, two species of sunfish, the small-mouthed black bass, a silurid fish, and at least one species of frog. The localities from which it has been reported are Kansas City, Mo.; Montreal, Ontario; Nebish, Mich.; Philadelphia, Pa.; Porto Rico; St. Paul, Minn.; Toronto, Ontario; Troy, N. Y. In most cases the seat of infection is in the muscles, but it was also found in the gills, the branchiostegal membranes, the fins, and the mouth. More than ordinary interest attaches to this worm from the fact that we have here a parasite which infests portions of the fish that are used as food. Osborn reports that at Nebish, Mich., in

1901, he found it in nearly all the bass that were submitted to him for examination, while in the perch it was much more rare.

He thus describes the appearance of these parasites in the flesh of the fish:

The cysts were very easily seen, being large, opaque and very creamy white, in marked contrast with the darker semi-translucent muscular tissue in which they lie embedded. When the fish were skinned in preparation for cooking the cyst walls were often torn open and the conspicuous worm seen moving on the surface of the meat. The cysts were found in all parts of the lateral muscles, deep and superficial, dorsal and ventral and headwards and tailwards. * * * The number of cysts in single individuals varied greatly. The minimum number found was seven and the maximum more than one hundred.

To the above localities and hosts of this parasite I am able to add another. In June of this year I found this distome in the brook trout of Alder Lake, Delaware County, N. Y. As this is the first record of the finding of this parasite in the trout I shall insert here a brief account of it.

The trout were not found to be badly infested, the distome being seen in only 17 of the 70 trout which I examined. No trout was found with more than 4 cysts in the flesh. Nine trout had 1 cyst each, seven had 2 cysts each, and one had 4 cysts. These worms were found in the larger trout. Thus 16 of the 17 parasitized fish were over $8\frac{1}{2}$ inches in length. Of the 70 trout examined 47 were $8\frac{1}{2}$ inches or over in length, and 16 of them had cysts in the flesh; 23 were less than $8\frac{1}{2}$ inches in length and only one of them was parasitized, it having 1 cyst in the flesh. The greater number of trout examined had been caught at the surface with the fly. On June 27 I examined 5 large trout from 9 to 10 inches long which had been caught with bait at the bottom. Each of these fish was parasitized having 1, 2, 2, 2 and 4 cysts in the flesh, respectively.

The cysts are easily seen, being usually slightly yellowish on account of the orange or salmon color of the contents of the intestinal tract of the enclosed distome. They were

found in several locations, viz., in the vicinity of the first dorsal fin, in front of the caudal fin, near the base of the anal fin and between the pectorals. Usually they lay deep in the muscle tissue near the supporting spines of the fins, though a few were found in the muscles but a little below the skin, and a few near the peritoneal lining of the body cavity. All were embedded in the muscle tissue. Of the 27 cysts that were found, 19 were in the vicinity of the first dorsal fin, 15 of them lying deep in the muscles and near the supporting spines of the fin, 2 near the exterior and 2 near the interior of the body wall; 4 were found deep in the muscles in front of the caudal fin, 2 were near the pectoral fins, and 2 near the supporting spines of the anal fin. In all cases the cysts were thin walled, so much so indeed that the distomes usually liberated themselves by their own exertions when the cysts were placed in water.

The distomes vary in size and are remarkably contractile. One of the larger specimens when removed from its cyst and placed in water was very active and varied in length from 3 to 10 millimeters. The neck in particular was very contractile, shortening until it was but a nodule and lengthening until it was slender and thread-like. The body was flat and leaf-like and the intestines were salmon color. In a lot of these distomes mounted in balsam the smallest is $3\frac{1}{2}$ millimeters long, 1 millimeter broad, and the largest is $7\frac{1}{2}$ millimeters long and 2 millimeters broad. In all cases, whatever the size, these distomes showed about the same stage of development, which was sufficiently far advanced to admit of specific determination, so that one can confidently refer them to the species found adult in the mouth and pharynx of the heron and the bittern.

Prof. R. Ramsay Wright, in 1877, reported a distome from the bittern (*Botanus minor*). The worms were found in the mouth at the sides of and below the tongue. MacCallum, in 1897, reported the same worm under a different name from the heron (*Ardea herodias*). Both of these hosts were obtained in Canada. Osborn in this current year

(1911) also reports this distome from a heron sent to him from Nebish, Mich. Although the bird had been dead a day or two, he found the worms still alive in considerable numbers adhering to the wall of the throat by means of the anterior end used as a sucker.

Upon comparing the distome from the flesh of the trout with published figures and descriptions of this adult form from the bittern and the heron it is evident that they are one and the same species.

Since it is possible to identify the species with such a degree of confidence, we are furnished with a clue to the source of infection of the trout of Alder Lake. Heron are not infrequent visitors at the lake, and the distomes now infesting the flesh of the trout in these waters, with little doubt, owe their existence to eggs which were introduced into the waters of the lake along with the excreta of some infected heron or herons which have visited the lake sometime within the past year or two. It should be stated that the worms were first observed in the flesh of the trout by Mr. L. F. Bliss, steward of Mr. S. D. Coykendall, the owner of the preserve upon which the lake is situated, in the autumn of 1910.

Trout are, as a rule, exceptionally free from parasites in the flesh. It is therefore worth while in a paper of this kind to consider the reasons for the exceptional occurrence of this distome in the trout of Alder Lake. It is to be noted that while the conditions under which the trout are living in this lake are not unnatural they are unusual. The level of the lake has been raised by a dam at the outlet over which trout cannot make their way from the stream below. To find a similar condition in nature where fish are living in a lake to which they are confined, that is, where they cannot move freely to and from the lake by means of the outlet, one must go to such a lake as Yellowstone Lake. It is of interest to note that in that lake the trout are likewise infested with a parasite in the flesh, and that the parasite is an immature cestode worm which reaches its adult stage in a

bird, the white pelican. It is manifest that fish thus confined to a lake are more exposed to infection than they would be if they spent all or even a part of their time in a running stream. Furthermore, the fish in a private preserve, being in large measure protected, would have a longer expectancy of life than fish living under similar conditions but without this protection.

The portion of the life-history of this flesh parasite of the trout which is comprised between the egg and the worm as it is found in the flesh of the trout is unknown. While at Alder Lake I examined a considerable number of snails and found rediæ in one species (*Planorbis trivolvis*). In each of these rediæ there was a large number of a very peculiar cercaria, a description of which must be left for a more technical paper than this. It is not possible at present to say to what species of distome these rediæ and their contained cercariæ belong.

Certain economic questions that are suggested by this flesh parasite are considered in the concluding section of this paper.

SKIN PARASITES OF FRESH-WATER FISHES

If one will take the trouble to examine closely the skin and the fins of a considerable number of fishes in certain localities he will be pretty sure to find a number of small spots of black pigment which, upon still closer examination, will reveal a small cyst in the midst of it. When this cyst is viewed with the aid of a compound microscope a young trematode may be discovered folded away within its walls. I have had sent to me from various localities specimens of the small-mouthed black bass upon which I have found these cysts. Following are brief notes made on two fish sent to me by Mr. C. W. Nash, of Toronto, Ontario, October 4, 1909:

Each of the fish had a few black pigment spots on the fins and one of them had a few also on the body, cheeks, and under side of the head. Upon opening the fish along

the back and stripping away the skin a few black pigment spots were found similar to those on the fins. Some of these, being in the dermis, adhered to the skin, others were in the muscle tissue although none of them lay deep in the muscles. All of them could be seen on the side of the muscle mass that had been next the skin. These pigment spots were rather more abundant along the back and on the posterior half of the body of the smaller fish, although they were also found in the muscles near the gill opening and in the pectoral muscles. About 53 were found in the flesh, and a few on the gill arches. In the larger fish the distribution was much as it was in the smaller specimen. There were about 30 cysts, mainly on the sides in the middle region, one being found in the muscles at the depth of 4 millimeters. Each cyst that was examined contained a larval trematode. So far as they were studied they were found to suggest the form described by Leidy under the name *Diplostomum gracile*, although one of them which was removed from the cyst and stained and mounted in balsam was thought to suggest the genus *Holostomum*.

In July, 1905, I spent one day at Alder Lake examining the brook trout for skin parasites. A description of conditions as they then existed has already been published (International Zoological Congress, 1907). While none of the trout had large numbers of cysts in the skin a large proportion of them were infected. A few had as many as 20 or 30 cysts visible on one side, some had none, others had from 1 to 5 on one side. Upon that occasion the owner was advised to discourage the visits of fish-eating birds to the lake as much as possible. This advice was followed. Upon my visit to Alder Lake this summer, after an interval of six years, I found the skin parasites of the trout less prevalent than they were in 1905. Of the 70 fish examined nearly half were without any cysts whatever.

I was not able to refer the larval distomes found in 1905 in these trout with certainty to any genus with which I was acquainted, although the genus *Diplostomum* was suggested.

This season my time was occupied with the flesh parasite, and I examined barely half a dozen of the cysts. In each case I found the cyst to be exceedingly thick walled and the contents degenerated to an indistinguishable granular mass.

While the generic identity of these encysted trematodes was not definitely ascertained, sufficient was revealed by their structure to indicate that they belonged to that group of trematodes whose adult stage is passed in the alimentary canals of fish-eating birds.

Hofer, in his *Handbuch der Fischkrankheiten* (Mun-chen, 1904), discusses such cases as these under the caption, "Die Diplostomumkrankheit or Diplostomiasis." These cysts have been recorded in a number of the European fresh water fishes. Their usual situation is in the skin, although at times they are found in the outer muscle layers beneath the skin. The encysted worm represents the larva of a trematode which is known under the name *Diplostomum* or *Holostomum cuticula*. Hofer's description of the appearance of these cysts in the skin of fishes is in practical agreement with what I have observed in the fishes that I have examined in this country. In the trout the presence of these skin parasites was indicated by black specks which upon narrow scrutiny were seen to consist of an accumulation of black pigment around a transparent cyst which is often silver white and shining like a small crystalline lens. This cyst usually lay just beneath the epidermis and projected slightly so that the surface containing a number of them presented an embossed superficies which could be detected by passing the hand lightly over it.

While the life-history of these parasites of fresh-water fish has not been worked out and must of necessity be conjectural, it may be said that there are the best of reasons for believing that they are due to eggs which have been discharged into the water along with the excreta of birds, and no reasons for believing otherwise. Of course, it is possible that the cercariæ of distomes whose adult stages are found in fishes and amphibians might become encysted in

the skin of fishes, but thus far the worms from these cysts that have been recognized have been forms whose round of life is completed in the alimentary canals of birds. As the case now stands, therefore, concerning the source of the trematode parasites in the flesh and skin of our fresh-water fishes, that source is to be found in certain fish-eating birds.

A SKIN PARASITE OF CERTAIN MARINE FISHES

In a report on fish parasites collected at Woods Hole in the summer of 1898, I noted the occurrence of cysts in the skin of the cunner *Tautogolabrus adspersus* (Bull. U. S. Fish Commission, vol. XIX, 1899, p. 296, pl. 40, fig. 76-81). These cysts had been made the subject of a paper by Ryder (Bull. U. S. Fish Commission, vol. IV, 1884, p. 37-42), who attributed the cysts to cercariæ. Later I recorded similar cysts from the tautog (*Tautoga onitis*) (Bull. U. S. Fish Commission, vol. XIX, 1899, p. 463, pl. XXVIII, fig. 38). Since then I have found these cysts in the skin of a number of fishes in the Woods Hole region, but in none so frequent nor so abundant as in the cunner and the tautog. As it is my purpose to prepare a special report for the Bureau of Fisheries on the skin parasites of fishes I shall reserve further details of distribution for that paper.

* In my report on cysts from the skin of the cunner I regarded these trematodes as distomes. Since that time—and especially this summer—I have removed a number of them from cysts, and, while I find them in agreement with my published figures, I also find that I misinterpreted one structure. In my figures a ventral sucker is indicated. Now this structure was not clearly defined, and perhaps should have been represented in a slightly different manner in the diagrams. A rudiment of a sucker-like organ is undoubtedly present, but instead of being a true ventral sucker it more probably represents the genital aperture characteristic of the family Siphoderidæ (Trematodes of the Dry Tortugas, Linton, 1910).

It was not until the present summer that this puzzling rudiment was understood, when the adult stage was found in the loon.

The prevalence of this form of parasitism among the cunners and tautog from certain localities is very great. Neither is it unusual to find individual cases of extreme abundance. In badly infested fish, not only the fins but the entire surface of the body, including the cornea of the eye, is thickly peppered with the cysts. Whenever a fish is thus badly infected the prevailing color is blue. Some idea of the great numbers of these cysts in extreme cases may be gained from the count given for the corneas of a tautog, one of the corneas being figured in the report cited above. The count showed 74 cysts in the cornea of one eye and 81 in the cornea of the other.

It is not at all improbable that a systematic study of these cysts will reveal trematodes of different species. So far as my examination has gone I am sure of only one species.

While examining a loon at Woods Hole on July 24, 1911, I found a very large number of small trematodes in the intestine which resembled the forms which I have obtained from cysts in the skin of the cunner and other fish of the Woods Hole region. Among them were young forms without ova. When these are compared with larvæ from the dermal cysts of the cunner the identity is established beyond doubt. Both are characterized by the same kind of oral sucker, pharynx, esophagus and intestine. The outline is similar in each and the surface of each is covered densely with very minute spines of like appearance. Instead of a ventral sucker a genital sucker is present in the adult. This median genital sucker made clear a heretofore baffling rudiment in the encysted larvæ which had been interpreted, not with entire satisfaction, to be the ventral sucker of a distome. A few examples of larvæ from cysts were obtained in which the rudiments of the testes and ovary could be distinguished, and were seen to occupy the same relative positions which they hold in the adult worms.

In collecting these trematodes from the loon, a portion of the intestine was scraped, the scrapings washed and the water decanted. The worms, then seen for the first time, were collected from the bottom of the dish. As their presence was not suspected until the material had been washed, no effort was made to remove all the worms that might be lodged in the mucous membrane of the intestine. Notwithstanding this, 4,789 specimens were counted. They presented a great variety of contraction shapes, but at rest they were usually long oval, widest at about the level of the posterior edge of the genital sucker, or a little back of that point, tapering most toward the anterior end. Some were nearly linear from the genital sucker to the anterior end, with the posterior portion broadly rounded; others were nearly linear throughout. There is considerable variation in size, though all are small, being less than 1 millimeter in length when uncompressed. One measured 0.75 millimeter in length, and 0.35 millimeter in greatest breadth; ova 0.04 by 0.02 millimeter. Further details will be given in a special report.

ECONOMIC CONSIDERATIONS

Since the thought of the presence of parasitic worms in our foodstuffs is such a disquieting one, this paper should not be brought to a close without at least a brief consideration of the insistent inquiry respecting the harmfulness to man of these parasites and of the question of their control, or extermination.

So far as known there is no danger that any of the parasites considered in this paper will develop in man. When it is remembered that the infected fish are eaten by a large number of other fish, in which these parasites do not come to maturity, and that even among the fish-eating birds the adult of the flesh parasite has been found in only two species, the bittern and the heron, and that the adult of the skin parasite has been recognized in but one species, the

loon, the chances that they would develop in so widely different a host as man are very remote indeed.

With respect to the skin parasites it will readily be seen that most of them are removed in the preparation of the fish for the table, so that the chances of any of them entering our food are not great. It may be a quieting thought also to remind those interested that the flesh parasites would hardly escape the notice of a careful cook. To all this it may be added that since we in this country prefer to have fish well cooked when it is served as food, the danger of infection from this source is reduced to a minimum even if the parasites were capable of continuing their development in a mammal host, and that mammal the genus man.

Nevertheless if the parasites are not injurious to man in a pathological way their presence in our food is still most objectionable. Indeed their presence in any considerable numbers in an occasional fish, or in any considerable proportion of fish, aside from the direct injury which they may inflict on the fish, will, of course, render them undesirable if not actually unfit for food.

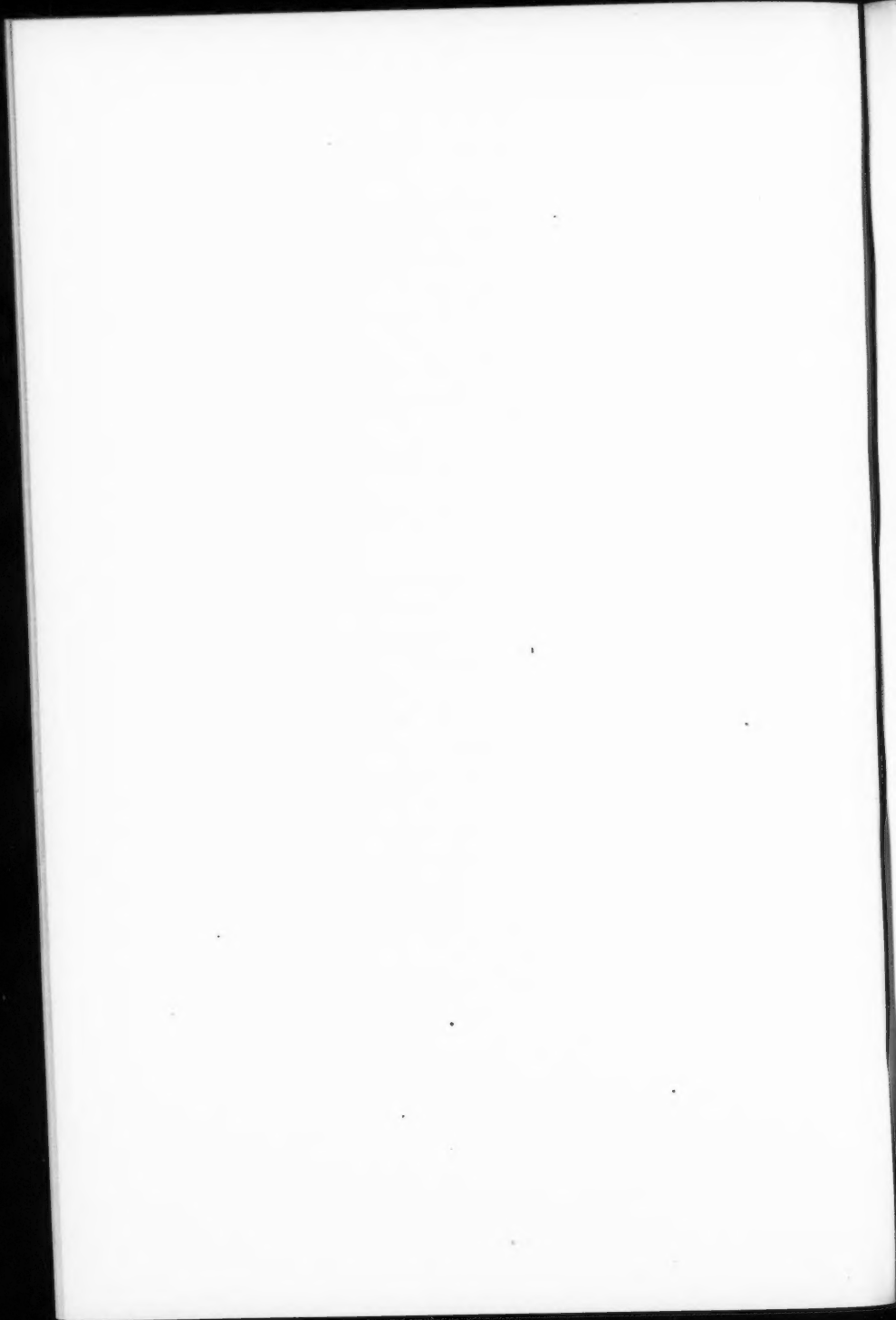
It should be borne in mind that neither the flesh parasite nor the skin parasite can multiply in its encysted state. Their only chance of attaining the adult egg-producing stage of existence is that they with their host be eaten by the particular kind of animal to whose alimentary canal they are by long adaptation and selection suited. Their prayer is for a suitable and timely devourer.

Since the original source of infection for both the flesh parasites and the skin parasites that are made the subjects of inquiry in this paper is found in a fish-eating bird, the control of both can be considered as one question.

Where fish are confined to ponds or small lakes the question resolves itself into the practical one of excluding fish-eating birds from small bodies of water. While such exclusion may not always be practicable, the infection of the waters may be in great measure prevented by vigilance in shooting objectionable bird visitors.

In large bodies of water or in the open sea, the problem becomes a more difficult one. And yet, even in such places, it is not incredible that some check is possible for these forms of parasitism.

There has been and is much laudable zeal displayed in the enactment of laws for the protection of birds. I hope that I shall not be misunderstood when I suggest that this zeal might be allowed to suffer some abatement, especially with respect to fish-eating birds. Surely the fish are deserving of some consideration as well as the birds, and man's comfort and well-being are still of vital interest and importance.



THE ABSORPTION OF FATS BY THE ALIMEN-
TARY TRACT, WITH SPECIAL REFERENCE
TO THE FUNCTION OF THE PYLORIC CÆCA
IN THE KING SALMON, ONCORHYNCHUS
TSCHAWYTSCHA.*

BY CHARLES W. GREENE

In an investigation of the distribution of fats in the king salmon, *Oncorhynchus tshawytscha*, pursued during the summer just closed, I have examined the various tissues and organs of the salmon including the different divisions of the alimentary canal. For the present purpose, omitting a review of the entire gross anatomy of the salmon, I will call your attention at once to the alimentary tract.

Description of alimentary tract.—The alimentary tract of the salmon is a very simple S-shaped tube. The only divisions of the tube are the stomach and the intestine with its appendages and glands. The first limb of the *S* is represented by the cardiac division of the stomach, the middle piece by the pyloric end of the stomach and the pyloric division of the intestine, and the last limb of the *S* by the long straight portion of the intestine ending in the rectum.

The most striking characteristic of this alimentary tube is the presence of the enormous number of diverticula, the pyloric cæca. The number of cæca in the king salmon varies from 140 to 185 as given by Jordan and Evermann in "Fishes of North and Middle America."

The cæca look like numerous rather large but slender worms attached to the pyloric division of the intestine. They are blind tubes varying in length from 10 to 13 cm. for the longest, down to 1 cm. for the shortest. The long cæca are at the beginning of the pyloric intestine and the short cæca at the other extreme of the pyloric region. The cæca vary in diameter from 0.5 to 0.8 cm.

* Published by permission of the U. S. Commissioner of Fisheries

The thickness of the cœcal wall and the diameter of the cavity within vary according to the degree of distension of the tube.

The detail of the histological structure is comparable to that of the intestinal tube of which the cœca form diverticula. The cœcum is covered with peritoneum and lined on the inside with a simple layer of mucous epithelium much folded. Listing all these coats and naming the parts from without inward they are: The serous coat, the longitudinal and circular muscular coats, and the mucous coat, consisting of the tunica propria, the stratum compactum and the mucous epithelium.

Method of observation.—The method used for the examination of the amount and histological distribution of fats was the newer modification of the Herxheimer method for staining fat with scarlet red, a method which has been recently improved and used with much success by Prof. E. T. Bell, now of the University of Minnesota, and his assistants. By this method portions of fresh tissue, or material that has been for a short time in ten per cent formalin, are sectioned by the freezing microtome method, transferred into seventy per cent alcohol, stained with alkaline alcoholic solution of scarlet red, and mounted in pure glycerine. Preparations sealed with paraffin keep more or less perfectly for a few weeks only.

Observations and hypotheses.—During the examination of the different tissues of the king salmon taken off the feeding grounds at Monterey Bay, Cal., it was noticed that varying quantities of fat droplets were always found in the pyloric cœca. The fat was located always in the epithelium and in that portion of the mucous coat described as the tunica propria. In certain preparations immense quantities of fat droplets were crowded into the cells of the epithelial coat. This loading of the epithelial cells with fat formed indeed a very striking picture. However, in sections prepared from different animals, and, in fact, often in different regions of one and the same section, the loading of

fat in the epithelium varied greatly in amount. The variation was so great that the question was immediately raised as to the source and nature of this fat.

Two hypotheses are possible in explanation, first, that the fat droplets were present merely as storage fat. If so it could legitimately be expected that the fat should have an even distribution through the various portions of the epithelial coat of the cœcum, also that there would be some uniformity of distribution in the different cœca of one and the same fish even though there might be variations in different fishes. The facts did not correspond with this expectation, as the previous statements have already indicated.

The second hypothesis in explanation of the facts observed is that the epithelial fat was in process of absorption. This hypothesis was supported, first, by the fact that the salmon under observation were feeding salmon, the food consisting of the Crustacea, molluscs, and other fishes of the region, many having a high percentage of fat in their composition. Furthermore, if the epithelial fat were absorption fat it certainly would vary in amount in different portions of the coat. Those portions of the epithelium in which adjacent folds are in contact would receive a relatively small amount of fat for absorption. Those portions of the mucous coat extending in folds well out into the middle of the lumen of the cœcum would naturally have a better contact with the food than the deeper portions just mentioned and have access to more fat.

The relation of the mucous epithelium to the other portions of the cœcal structure can be seen in the sections showing fat absorption. Highly magnified portions of the epithelium show the cells charged with fat. In some preparations the free ends of the epithelial cells are filled with relatively large sized fat droplets in that portion of the cell nearest the nucleus. In the extreme distal ends of the cells of these sections the fat is in very minute droplets, discernible only with the oil immersion lens. The material also shows a

transparent striated border which is more or less characteristic of intestinal epithelium in general. The basal portions of the epithelial cells have a relatively small quantity of fat in medium sized droplets. The loading of the cells is great in the distal ends and slight in the basal ends, as is readily seen in numerous preparations. In the connective tissue stroma, between the two folds of the epithelium, fat is present in relatively small amount and in the form of comparatively large droplets. In contrast with this stage in absorption is that in which the free ends of the epithelial cells are practically free of fat, while the basal portions of the cells are crowded full of extremely finely divided fat. The submucous zone, or stroma, has a relatively large amount of fat in small droplets. Considering the two showings together one cannot escape the conclusion that we have to deal here with two stages of fat absorption rather than with a problem of fat storage.

In material taken from the sea fish, as shown in the above cases, one has neither choice nor accurate knowledge of the stage of feeding represented by a given individual. However, I attempted on the basis of the amount and stage of digestion of the food present in the stomach and intestine, to select salmon representing possible stages in the process of fat absorption. A series of three salmon were procured, all with considerable food in the alimentary tract—one with slight, one with medium, and one with advanced stage of liquefaction of this food. A microscopic examination of the pyloric cœca of this series tended, with some degree of uncertainty, to confirm the assumption made in their selection, namely, that they would show increasing amounts of fat in the mucous epithelial cells as digestion and absorption proceeded.

While these observations were in progress, at the invitation of Dr. Charles H. Gilbert, of Stanford University, I visited the Santa Clara County trout hatchery at Brookdale, Cal., that I might secure samples of young salmon for comparative histological purposes. The station had

on hand some two-year-old salmon; also some yearlings. Specimens of both were secured, killed and prepared for comparison with the adult fish in points with respect to the general study being pursued. I also transported living specimens of these salmon in fish cans to the Hopkins Seaside Laboratory at Pacific Grove, Cal. These young live salmon were intended for use as a check on the general fat content of adult salmon secured through the Monterey fisheries. A microscopic examination of the tissues of one of the largest of these specimens showed among other things that the intestine and the pyloric cœca contained neutral fat, but that the fat was located chiefly in the tunica propria. The cells of the epithelial coat were almost entirely free of fat in this specimen. A second specimen, put in preservative at the Brookdale station, showed a small amount of fat in the epithelial coats of the intestine and the cœca. This dearth of fat in the epithelial coats of the young salmon was in sharp contrast to the relatively large amounts of fat always found in the epithelium of the cœca of the adult salmon.

Experimental test of the fat-absorbing power of the pyloric cœca.—It was determined to make a test of the fat-absorbing properties of the pyloric cœca on the young king salmon, for which purpose two of the larger salmon and four of the smaller ones were still available. The two larger salmon were 14 and 16 centimeters long respectively. These young fish had not been fed since removal from the Brookdale aquarium, so that the alimentary tracts were assumed to be practically free from fat, an assumption checked by the specimens previously examined.

The salmon in the experiment were fed olive oil. The attempt was made at first to give olive oil mixed with enough coagulated milk to hold the oil in the semi-solid mass of the milk curd. This mixture was injected through the mouth into the stomach by means of a syringe with large opening. But quantities of the milk coagulum were immediately ejected by the salmon when set free and one could

not determine whether any of the oil was retained. The specimens were therefore immediately fed pure clive oil, this time by way of the rectum.

A small quantity of oil was taken into a medicine dropper, the glass point of which had previously been drawn out to the proper size. The tip of the dropper was then inserted through the anus into the rectum and the oil gently injected until it was judged a sufficient quantity had been used to fill the small intestine as far forward as the pyloric division. Of the larger salmon one received a relatively large quantity of oil, the other a smaller quantity. Of the small salmon no attempt was made to differentiate them as regards the quantity of oil used.

All the fish were in good condition, were sprightly following the giving of the oil, and they remained so until they were killed in the experiment. The first specimen, no. 45, 14 centimeters long, was killed after 19 hours. The second specimen, no. 46, was killed after 42 hours. The smaller fish were used as corroborative material and were killed at later periods.

Detailed results of the Brookdale salmon fat-feeding experiment.—The young salmon, no. 45, was killed by cutting off its head. The alimentary tract was carefully removed and portions of it examined perfectly fresh, other portions were fixed in formalin, and still other portions in solutions preparatory to paraffin sectioning. The fresh material was frozen and cut on the Bardeen freezing microtome. The sections were cut into seventy per cent alcohol and were immediately after stained in alkaline scarlet red. Formalin fixed sections were also stained for fat. Later paraffin sections were made for the study of structural details.

The cross sections of the pyloric cœca of the young 14 centimeter salmon show a comparatively simple folding of the mucous epithelium, also the stratum compactum seems relatively undeveloped and the cœca are correspondingly

small. Aside from these facts the cœca have a structure comparable to that of the adult salmon.

The epithelial layer of the cœcum of this salmon fed 19 hours before with oil was found to be simply crowded with fat droplets. With the low power magnification this coat in which the fat is stained with scarlet red is so full of oil that it appears of almost a uniform scarlet color. In the portions of the epithelial coat lying nearer the deeper grooves in which the adjacent mucous surfaces are more or less in contact, thus preventing free contact with the fat within the lumen of the cœcum, the epithelium was not always filled with fat. This fact was more prominent in the more sparingly fed fish no. 46. In other words, considering the picture as a whole, it was found that there was not a uniform filling of the epithelial cells with fat in all portions of the cœcum. In those portions of the epithelium in which the sections showed the presence in the lumen of the cœcum of large quantities of free fat in close contact with the epithelial coat, the coat itself was so gorged with fat droplets as to make it difficult to determine the cellular outlines. In fat-stained frozen sections that were counterstained with hæmatoxylin the nuclei are shown as a layer at about the basal third of the cells. At the stage in the process of absorption represented by no. 45 the greater masses of the fat are in droplets in the outer two-thirds of the epithelial cells. In this young specimen the fat drops seem unusually large, much larger than those observed in the ordinary course of absorption shown by the pyloric mucous epithelium of adult fish caught in the sea. The bases of the epithelial cells in those regions where active absorption is taking place contain fat droplets, but the droplets are smaller and not so numerous. Also, in such regions fat was found to have penetrated into the tunica propria where droplets of considerable size are distributed along the strands of connective tissue of the tunica. The fat droplets in the tunica propria are comparatively numerous in the three experimental specimens of this group. On the whole, the

amount of fat in this region was considerably increased over that in the normal animal. Different portions of the tunica propria are not uniformly charged with fat droplets. The fat extends down to the stratum compactum, but not beyond in any case. It seems that the stratum compactum acts as a definite bounding membrane to the mass movement of the fat in the submucous layer. Apparently the fat is taken from this region by some mechanism acting through the agency of the circulatory system.

Various sections of the pyloric cæca revealed the same general picture of the passage of fat droplets through the mucous epithelial coat that has previously been described for fish no. 45. The fat was present in surprisingly large drops in the outer layer or zone of the epithelial cells. It was also present in the basal portions of these cells and present in considerable quantities in the underlying tunica propria.

The intestinal tract in all the regions of no. 46 examined showed fat in process of absorption through the mucous epithelium.

One individual of the smaller sized salmon was examined with reference to the fat absorption. It showed a picture structurally comparable to that of the larger salmon. The very small diameter of the pyloric cæca renders their examination relatively difficult, yet the details of the distribution of fat in the mucous epithelium can only be interpreted as confirming the deduction made from the two larger specimens, *i. e.*, that *the fat fed in these experiments was being actively absorbed by the pyloric cæca and the intestine.*

DISCUSSION

DR. H. B. WARD, Urbana, Ill.: I would like to ask a question. Do I understand that you used salmon that had passed out of salt water into fresh water, or were they king salmon still in salt water and feeding?

DR. GREENE: The first experiments were on naturally feeding salt-water king salmon; the experiments in which I myself fed the fish artificially were on young king salmon that had not yet gone into salt water—some of them were two and some one year old.

DR. WARD: Have you tried this on fish after they leave salt water, so that you can say whether there is any absorption?

DR. GREENE: That question I suspect does not mean as much to some of the gentlemen present as it does to the gentleman who asked the question. Those who are familiar with the situation know that the king salmon do not eat after they leave salt water on their return journey to the fresh waters for spawning purposes. A still larger number do not know that in this fasting journey there is a marked retrogression in the whole alimentary tract. That is a problem I have been working on and I now have a considerable mass of scientific material tending to show that this tract not only markedly degenerates in size, but changes in a very profound way in histological structure. These changes in structure practically answer the question.

One would not expect the salmon that have undergone the extreme changes to show the same absorbing power that the young salmon do that were eating but had not yet gone to sea; or that the old salmon still eating and in the sea show. The fact is that the epithelial coat of the cœca has practically disappeared. I have histological sections of material of far-changed spawning salmon in which there is no epithelial coat present either on the cœca or on the intestine. So, of course, in such cases absorption would be wholly different from the normal absorption of food material.

DR. WARD: Taking them about the time they stop feeding, can you keep them absorbing longer than they otherwise would? In other words, does the stoppage of absorption follow the stoppage of feeding; or does the stoppage of feeding become associated with the tendency to degenerate in the alimentary canal? Which is the primary and which is the secondary feature?

DR. GREENE: I have not made those tests and do not think I can answer the question. It is a factor that is too much involved in certain physiological processes to be directly determined by histological evidence alone. It is also very difficult to detect the moment when the normal structure begins to change over to this special degenerative structure. I suppose that in the earliest stages of this change the tissue, having already entered a pathological state, may still be capable of absorbing, though I doubt it. I do not know; I am only guessing at that. I cannot guess with assurance in our present state of knowledge.

The interesting factor behind these questions asked by Dr. Ward is this factor of degenerative change, not only in the alimentary tract but in all other parts of the body save one, the reproductive organs, during the migration from the feeding grounds of the sea back to the spawning grounds. This is one of the most interesting of biological facts, as far as its physiological bearing is concerned. I am personally of the opinion that the cessation of feeding, therefore of absorption, and the broad changes in the skin, muscles, etc., are all expressions of the one physiological condition that culminates in the spawning process.

The latter part of the presentation of my paper seemed to me very inadequate, a matter that will be adjusted by the publication of the paper itself, but I want to raise one question of general bearing in reference to physiological work in the study of fishes. I know that this Society has long since emphasized questions in relation to fish foods, environment for fishes, also the economic side of the production of large quantities of fish. To me many of those problems have a possible solution in a better knowledge of the physiological functions of fishes, as is true, of course, of that more remote complex of factors which result in the infection of fishes, thus leading to abnormal functional states.

It is obviously as important to understand the ability of the fish to utilize food as to understand the ability of the fish to catch food. I do not mean, however, to discuss this point any further than merely to call attention to it.

THE PRIBILOF FUR SEAL HERD AND THE PROSPECTS FOR ITS INCREASE

By C. H. TOWNSEND

After more than twenty years of active operation, the pelagic sealing industry has been brought to an end, as the result of an international conference which has been held at the Department of State. The convention has been signed by representatives of the United States, Great Britain, Russia and Japan, and the Senate of the United States has ratified it.

The contracting parties have agreed to prohibit their vessels from engaging in pelagic sealing and to close their ports against all vessels connected in any way with the operations of pelagic sealing. It is not necessary in this connection to go into the details of the seventeen articles of the convention, which is to continue in force for a period of fifteen years from December 15, 1911.

The total loss of seals from the North Pacific herds through pelagic sealing since its inception may be placed at about three millions. As a large proportion of this catch consisted of females, the disastrous effect upon the breeding stock of the Pribilof and Commander Islands will be readily appreciated.

The fur seal industry, both at sea and on land, was for many years the subject of almost continuous international controversy, and the Pribilof herd especially has been studied long and carefully by commissions selected chiefly from the ranks of British and American naturalists.

The facts respecting the fur seal's habits, migrations, food, breeding, growth, age, numbers, anatomy, enemies, etc., as arrived at by the commissions appointed to study the subject in general, afloat and ashore, cannot reasonably

be questioned. They are based upon prolonged inquiry by representatives of the two countries most interested, and have been mutually accepted only after the keenest possible criticism from both sides.

The natural history of the fur seal is now better understood in detail than that of any other wild mammal. These investigations, commenced about twenty years ago, have yielded much new information, and, with the cessation of pelagic sealing, we are now ready to apply scientific methods to the rehabilitation of the small herd remaining on the Pribilofs with full confidence as to the result.

The polygamous habit of the fur seal is the principal fact with which we have to deal in considering any scheme of management of this animal upon its natural breeding grounds. Each mature male controls from 1 to 100 females, the average number of females in the harem into which the rookeries are divided being about thirty. The surplus of male seals naturally resulting from the polygamous habits of the animal is large, and the most of it has always been available for commercial purposes.

The male seals are thus of two distinct classes: the adults in possession of the breeding grounds, and the immature males located entirely away from such grounds. The latter do not acquire the size and courage to fight their way among the large breeding animals until about seven years old, although otherwise mature at the age of four years.

During the breeding season the mature males are in possession of the harems, where they maintain their positions by sheer fighting ability. Their courage is such that they do not give way even before men armed with heavy clubs and it is dangerous for men to attempt to enter the rookeries at this time. When the males seize each other with their powerful jaws they frequently tear rents in their thick hides. In a quarrel for the possession of a female, the latter may be frightfully lacerated, and is sometimes killed. Fighting may be seen anywhere in the rookeries and many of the very young seals are trampled to death.

The destruction of young through the fighting of the bulls is of serious extent even when large numbers of surplus males are annually killed for marketable skins. It must have been vastly more serious prior to the utilization of sealskins by man.

It is the belief of naturalists who have studied the fur seal on its native islands that the furious fighting of the males upon the breeding grounds actually constituted Nature's check to the unlimited increase of the race. It could have been nothing else, although the worm parasite (*Uncinaria*) of the sand areas must be considered to some extent in this connection.

Prior to the discovery of the Pribilofs the breeding grounds were undoubtedly overflowed at times by such hordes of mature males that an important proportion of the young of the year, and many adult females, were destroyed.

There can be no doubt that the annual reduction of the male surplus for commercial purposes since the discovery of the islands has greatly lessened the breeding-time turmoil of the rookeries, and that proportionately large numbers of young survive the perils of infancy. Now that pelagic sealing, so wasteful of the adult female life, has been suppressed, we may expect an annual expansion of our shrunken breeding grounds.

The male stock of the islands should be watched with great care and its numbers kept within safe bounds. A sudden increase of fighting males in the rookeries at a time when the stock of females has reached the lowest limit in the history of the islands, would greatly endanger the newly born young.

Here we may take up a matter of importance to this Society. A resolution was introduced in the House of Representatives on August 12 to provide for the suspension of all seal killing on the Pribilofs for a period of fifteen years. This resolution may come up for consideration when Congress convenes. Its passage would be unwise in many ways, but chiefly in the danger of a rapid increase in fighting male

seals which it would bring about. While a cessation of land killing for a season or two might cause no serious trouble, the fifteen year period specified is not only too long but positively dangerous, as the Bureau of Fisheries would be powerless to apply the necessary remedy for the evil of overcrowding by males when it becomes serious.

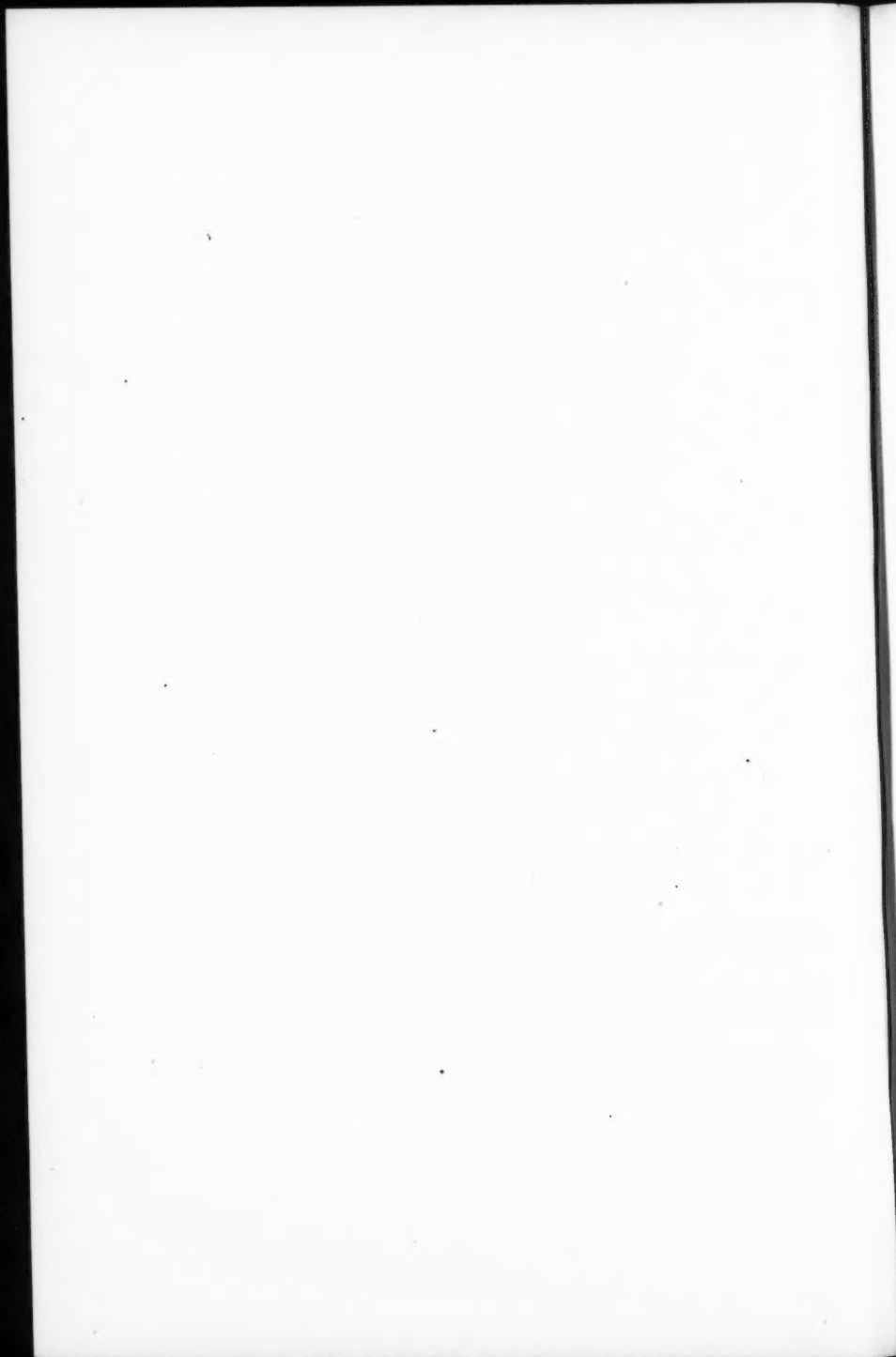
The criticism of the administration of the seal islands which called forth the above resolution of August 12, 1911, was made by men who have not been on the islands for twenty years and who cannot appreciate the recent detailed investigations. Severe criticisms have also been made by men who have not been there at all, and whose opinions upon the subject are of little value.

Plans have been considered for reducing the loss due to the hookworm *Uncinaria*. The breeding grounds of the Pribilofs are located largely upon rocky ground or upon firm soil and have sufficient slope as a rule to prevent the accumulation of sand. There are small patches within the limits of several rookeries which are infested with the parasite *Uncinaria*. This hookworm is responsible for heavy annual losses among the young seals born on sandy areas. The *Uncinaria* parasite was doubtless a greater source of danger in former years than at present. It was, like the fighting of the males, a natural check upon the unlimited expansion of the seal herd, but not so potent. The topography of some of the rookeries is such that an extension of their limits would force the breeding females to occupy unfavorable sandy areas. This source of danger to young seals can be eliminated, if sandy ground is covered with rock, or fenced in so that breeding seals cannot occupy it.

In conclusion it may be stated that with our present knowledge of the life history of the fur seal, there is no reason why our valuable herd should not only rapidly increase in size, but under wise management, actually exceed in numbers the great herds occupying the Pribilof Islands at the time of their discovery.

The principal thing in the management of the rookeries will be, however, the limiting of the number of adult males allowed to enter the rookeries.

Notwithstanding the fact that during recent years a very large proportion of the surplus males has been killed for profit, our annual photographic records show that there has always been, with the exception of one or two seasons, a sufficient surplus of idle males adjacent to each rookery. Such animals force their way in as soon as they acquire the weight and the courage necessary for them to do so. All claims that we have killed too many of the surplus males can easily be disproved by the photographic records of the Bureau of Fisheries.



NOTES ON SOME SELDOM MARKETED SALT-WATER FISHES

BY JOHN TREADWELL NICHOLS

Probably in the long run the best food fishes, and those most readily accessible for market purposes, are the ones that it is customary to use as food. On the other hand a casual survey shows many salt water forms which, though eaten in foreign countries, are not utilized in America.

It seems to me that this is a matter which is particularly appropriate for the American Fisheries Society to bear in mind, to the end that the utilization of fishes for food shall be based on a true knowledge of their value, influenced as little as possible by custom and prejudice. I therefore venture to submit a few brief notes, personal experience with fishes which are not regularly marketed.

The mud cat, *Leptocottus armatus*, is a salt water sculpin of small size, very abundant the length of the Pacific Coast. Like all the sculpins it has a large spiny head, and probably more or less on that account is not eaten. At Seaside, Oregon, a Chinaman had cut the heads off a number of them and was taking them home to eat. With the heads gone they looked something like tomcod. He said they were very good. Some small ones about five inches long, from sandy bottom in summer, were fried. They were very sweet and palatable, though their meat was not very firm.

The sea robin, *Prionotus carolinus*, is a very abundant fish in all salt waters near New York. It has a large, hard spiny head and is generally thrown away when caught. A large one about a foot long and a smaller, about eight inches long, were eaten fried. Both were moderately good but the larger had a strong muddy taste, perhaps due to the water where it was taken. The fish is a rather close relative of the European gurnards, some of which are highly prized for the table.

The fresh water silverside, *Menidia beryllina*, is the delicious little fish commonly sold in bulk in the New York market as "whitebait," and eaten head and all, fried. It is very abundant in certain clear, fresh head waters of Moriches Bay, L. I., and is netted extensively for the market. The salt water silverside, *Menidia notata*, resembling it so much in appearance as to be distinguished with difficulty, abounds in the salt and brackish waters adjoining. It grows to a larger size and is edible, but much poorer than the other, as it is less meaty, more bony, and sometimes tastes muddy. It is more difficult to obtain as the schools are not as dense, and the fish in them are less uniform in size.

Two delicious little salt-water fishes which would make as good "white bait" as the fresh water silverside, are the striped and Mitchill's anchovies, *Stolephorus brownii* and *mitchilli*. Both of these occur near New York, though the writer has eaten them only in Florida. He has there eaten the striped anchovy as large as a small smelt, and an unrelated slender fish, the halfbeak, *Hyporhamphus unifasciatus*, somewhat larger. The two last mentioned were eaten by several persons and pronounced excellent.

In the winter of 1909-1910, while engaged in collecting fishes for the American Museum of Natural History in Florida, we caught many species in the seine daily, and from time to time would pick out one or two of the best for the table. Notwithstanding its somewhat unprepossessing appearance, the snook, *Centropomus undecimalis*, weighing five or ten pounds, was found to be a food fish of the very first rank. Despite its northern reputation, the sheepshead, *Archosargus probatocephalus*, taken at the same time in the same waters, was pronounced much inferior by several persons; in fact it was rather tough and tasteless and we only ate it once or twice.

The sundial, *Lophopsetta maculata*, common near New York, is a small flounder not utilized for food. It is flat and thin and its flesh is translucent. Nevertheless a young speci-

men about six inches long, taken this summer from the muddy waters of Moriches Bay, proved to be very sweet and delicious fried. Full grown ones would probably be better. The turbot, which is a large European relative of this species, also has a somewhat translucent flesh.

The U. S. Bureau of Fisheries has recently carefully investigated the food properties of the dogfish and found this a good food fish. My only experience with its giant relative, the shark, is different. A number of years ago, at sea in a sailing ship, from time to time in calm, warm weather, sharks would follow the ship. We caught one of them eight or ten feet long, the species of which unfortunately was not determined. Its flesh was white and beautiful to look upon but decidedly tough and unpalatable. Professor Dean tells me, however, that young sharks are commonly eaten abroad (Italy, Spain, and especially in Japan). In the last named country a blanc-mange-like jelly is made of the meat of sharks and is pronounced delicious by travelers. Shark fins are prized by the Chinese.

The skate (*Raja*) of which there are several species abundant on both our coasts, seems to have been practically unused for food in America until very recently. The New York fish dealers with whom I have spoken are agreed that until three or four years ago very little was sold here. More and more is now being sold, particularly to the Italians. At Blackford's Market (Blackford is perhaps the largest Fulton Market fish dealer) a buyer estimated for me that about 200 pounds of skate a day is now sold in the New York market throughout the year. This comes to about 72,000 pounds a year, and from the statements of other dealers is, I think, a very conservative estimate. Retailers on the upper west side whose trade is of the better class say they seldom handle it; two fish dealers in an Italian quarter on 7th Avenue near 30th Street, sold 50 to 100 pounds a week, one of the fish dealers in the Washington Market claimed to sell 60 pounds a day. Only the pec-

toral fins, "wings," are used, the trunk and tail being thrown away.

The Washington Market dealer mentioned said that the French people in New York were beginning to buy skate as a delicacy under the name "laræ." At Boulogne, France, the writer has seen quantities of it marketed.

DISCUSSION

DR. TARLETON H. BEAN, Albany, N. Y.: I am pretty well acquainted with some of these fish, as we get them in New York waters, and I should be glad to comment on some of them.

The fresh-water silverside, *Menidia beryllina*, I am inclined to think, is erroneously identified, unless the fauna has changed since my collecting experience in Great South Bay. The common species in Great South Bay is the *notata*, with rather heavy, rough scales and broad silvery streak on the side; and it forms a very large portion of the bulk of the so-called whitebait in New York city. The *beryllina* runs up into the fresh or slightly brackish portions of Great South Bay and its adjacent waters, but, as I have said, it is extremely uncommon. You will find it farther south, say in Great Egg Harbor Bay, New Jersey, and there it begins to be abundant, but not in Great South Bay, unless times have changed very recently.

These anchovies mentioned, the *Stolephorus brownii* and *mitchilli* and the third one that has not been named because it is rather rare—the *perfasciatus* of Poey, the common name of which I do not know—are good fish unless they feed on a certain species of algæ, which gives them a stain and a bitter flavor. Otherwise they are the very finest of salt-water fishes. Their flesh is transparent and simply delicious, although they are very small, of course.

I have heard the remark made about the southern sheephead. Mr. Worth is more familiar with that, undoubtedly, than I am. The southern sheephead does not appear to be held in esteem as a food, as compared with the northern species. They belong to the same species, but the southern one is smaller and has different feeding grounds and habits perhaps; and it does not have the flavor of the well-known sheephead of New Jersey and New York.

The spotted flounder, which Mr. Nichols calls sundial, I have heard mentioned as a good food fish. I tried to eat it once and it seemed to me tough and tasteless.

The skates, of course, for many years have been sold in New York; but the work was done so quietly that few people were aware of what they were doing. The wings, or pectoral fins, are delicious.

Another fish well known to most of us, that Mr. Nichols does not name, is the sea lamprey. It runs up in the spring and is eaten in

enormous quantities, particularly by the Frenchmen, not only in New York, but in Connecticut and other New England states.

PROF. L. L. DYCHE, Pratt, Kan.: It seems to me there are a great many things good to eat that we do not eat because we have not been accustomed to them. Between 40 and 50 years ago Indians were camped near my father's farm in Osage County, Kan.; and I did not think much about Indians being different from other people. We used to go to the Indian camps and I ate about everything that could be put on an Indian bill-of-fare. I ate turtles roasted in the fire, muskrats, and I am not sure but that I ate snakes and many other things I did not know much about. In later years we learned to eat opossum; and if any animal is unfit to eat on account of its promiscuous food habits, we believe it is the opossum; but the "possum" meat tasted pretty good. A few years ago we collected about 50 skins of the large striped skunks; and one day we caught two fine fellows, two-thirds grown. The scent glands are two balls about three-quarters of an inch in diameter. These were carefully removed and there was no more odor about those animals than about an opossum, a raccoon or a small pig, and perhaps not so much. My assistant, Mr. E. D. Eames, and I conceived the idea that they might be baked for Thanksgiving and that we might have a big "possum" feed. We had the banquet, and after the guests ate we told them what the meat was, but we could hardly make them believe it. The meat was tender, juicy and sweet, and with no foreign or suspicious taste. We had eaten the same meat before and knew that it would be good.

On the coast of Greenland I ate a number of things that people are not accustomed to eat. The Danes in south and central Greenland are accustomed to eat whalemeat and especially the skin of the smaller varieties of whales. Eskimos are very fond of it and eat both meat and skin raw. When an Eskimo harpoons a small whale he always gets the tail in addition to his regular portion in the division of the meat. We travelled with these Eskimos and ate what they did. We ate seal meat and shark. I never cared for shark. There is not much flavor to it. But I think if it could be cooked with good Kansas or Missouri bacon to give it a flavor, it would be much improved. Whale skin, when boiled or scalded in hot water, turns white, and it is pretty good when eaten with vinegar or sour dressing. We have eaten the raw skin of the whale while in company with Eskimos. It was a good food, but with no particular taste. A piece as large as your two hands would satisfy an ordinary appetite. It has no bad taste or flavor, and inasmuch as the Eskimo prized it highly we considered that it must be a good food. We ate several things on the Greenland coast, such as seahawks, gulls, shearwaters, guillemots, etc., that people do not often eat. The Newfoundland sailors are more or less superstitious and would not eat a mouthful of bear meat. But they did eat what seemed to be salt horse meat that had been packed in barrels. They would eat that old, strong and tasteless meat in preference to nice, juicy bear steaks

cooked in the finest way. I preferred bear steaks to almost any kind of salt meat. I see by the papers that there was an Indian feast here in St. Louis last night where 150 people partook of boiled dog as the chief and almost only thing on the menu. I have eaten dog and I feel somewhat slighted that I was not invited to the feast.

MR. MEEHAN: I can sympathize with Professor Dyche as to food in Greenland. I ate some of the narwhal skin in McCormick Bay and found it did not have much of a taste. It is a little difficult to describe. Upon starting it was something like biting India rubber, but your teeth came to with a snap. It had a rather bluish tinge, and was supposed to have a nutty taste, but I did not distinguish it. I attempted on one occasion to eat seal meat that was ripe, killed the winter before, but the odor was much stronger than the flavor of the meat. Being in an experimental frame of mind I tried to eat it.

One of the things I did not attempt to touch, however, was the little creature quite abundant in the hair of the Eskimo, of which they seem to be particularly fond. Quite frequently I have seen them take the little creature as a sort of dessert to their meals.

PROFESSOR DYCHE: I forgot that.

MR. MEEHAN: I remember on one occasion when an Eskimo was remonstrated with for using that dessert he turned around and said he could not see that it was any worse than what the white people did who ate shrimps caught in the water in great abundance and which are known to the Newfoundland sailors as sea lice.

DR. BEAN: I heard an Eskimo explain the habit. When I remonstrated with him for eating the louse, he replied, "He eat me, why më no eat him!"—Reciprocity. (Laughter.)

UTILIZATION OF THE DOGFISH

By G. W. FIELD

In the first place I ought to say that the species about which I speak is not the dogfish of the middle west, but a species of shark common in various salt waters all over the world and of very general interest on that account. As you know, it is also one of the most abundant of the sharks, just how abundant is not really known; but four or five years ago we attempted to estimate the number by means of statements from upwards of 500 captains sailing out of Boston and Gloucester. We asked them to make a careful estimate of the number of dogfish they caught during the season, and they reported 27,000,000, actually caught on their lines, trawls and nets—27,000,000 dogfish averaging about 7 pounds apiece. In other words, they caught more dogfish than cod, haddock or other fish. They bring into Boston and Gloucester about 200,000,000 pounds of fish annually; and the catch of dogfish alone is practically equal to their entire catch of halibut, cod, haddock and other species combined.

At the same time we attempted to find out approximately how much damage was actually done by dogfish to the nets and trawls of the fishermen. Upon investigation we learned this to be in round numbers about 160,000 pieces of line, etc., with bait attached. As you know, bait in the salt-water fisheries is a very important item, costing 50 cents a barrel and upwards, and fishermen are willing to pay almost any price for the right kind.

But more than that, when the fishermen lifted their trawls, which are often a mile or more in length and have say 2,000 hooks each hanging by a short line every 6 feet, they sometimes found over 1,500 dogfish. On the rest of the 2,000 hooks they found not dogfish, but the heads of codfish and haddock which had been entirely eaten by the dogfish.

When I say the damage by dogfish to bait, nets and trawls is upwards of over \$400,000 a year to the Massachusetts fishermen alone, I am well within bounds.

So after all the question of utilizing these dogfish is very important, particularly for the reason that dogfish live almost exclusively upon the edible fish, the young cod and other bottom fish, the lobster, the young of various surface-feeding fishes, mackerel and other species. If we assume that they eat only one or two pounds of fish a day at a cent a pound, and there are at least 27,000,000 doing business all the time, the daily destruction of fish, for which we pay 5 or 10 cents a pound, is very considerable, certainly figuring up a damage of \$5,000,000 or \$10,000,000 a year at a very conservative estimate. We do not know how much it really costs, but it is certainly going on.

How numerous these sharks are is also shown from the fact that there is a record of an otter-trawl taking over seven tons of dogfish at a single haul. A net about 100 feet across the mouth, dragged on the bottom, brought up at one haul over seven tons of dogfish alone!

Thus the problem of utilizing these dogfish becomes very important. The United States Bureau of Fisheries has done excellent work in urging the utilization of these fish as food. They are prized in other sections of the world as food, but we have not come to that in this country, although, as the Bureau has pointed out, they are as good as many of the fish that are already fashionable.

I believe thoroughly that many tons of these dogfish could be utilized by being dried, ground and used as pig and poultry food, or as food for horses, as they are actually used in Cape Breton. There they are caught and hung on the fences to dry and then used as horse food; about one dogfish a week is given to keep a horse in good condition. Any residue could doubtless be used as fertilizer. Dogfish would constitute a more truly economic source of nitrogenous fertilizer than the menhaden; it is not used as staple food by any other species of economic fishes, as are the menhaden.

So on the one hand we are destroying the alewife and menhaden, upon which many of our fisheries depend for bait, while on the other hand we are leaving in the water the enemy which is destroying countless numbers of our most valuable fishes.

We have therefore made some observations to determine what is the practical value of the dogfish. To put it very briefly, we have found that the oil in the liver is about 50 per cent of the weight of the liver. This oil can be sold for about 25 to 35 cents a gallon, so that one dogfish would ordinarily yield about $2\frac{3}{4}$ cents worth of oil. In addition to that there is the body, which as a fertilizer is worth \$27 to \$35 a ton at present. The dogfish then at that rate would be worth about 3 cents for fertilizer, making altogether $5\frac{3}{4}$ cents. Experiments are still under way to determine whether or not the peritoneum of the dogfish may be used for surgical dressings. I am not prepared to go into that, but it may be an important factor. The peritoneum, you recall, is the delicate covering of the liver, intestines, etc., which can be separated as a very thin, delicate membrane.

Finally, and perhaps most important, we have made some experiments to ascertain the value of the eggs of the dogfish. Each female dogfish yields from four to eight eggs; how often we do not know, but probably two or three times a year. These eggs are retained in the body of the dogfish until they are hatched. The young are born alive. We find that the eggs can be used by tanners as hen's eggs are used. For a practical demonstration we furnished the tanners with about 75 pounds of the eggs, and we received a report that they could be used the same as hen's eggs. You know that in preparing glove leather it is important to get the oil into the leather in such a way that the leather will not remain greasy. For this purpose they make an emulsion of the oil and treat the skin with it. Hen's eggs are used by stirring them up in the oil, and thus used it is found that one dogfish egg is equal to two hen's eggs. In other words, one dogfish egg will emulsify as much oil as will two hen's

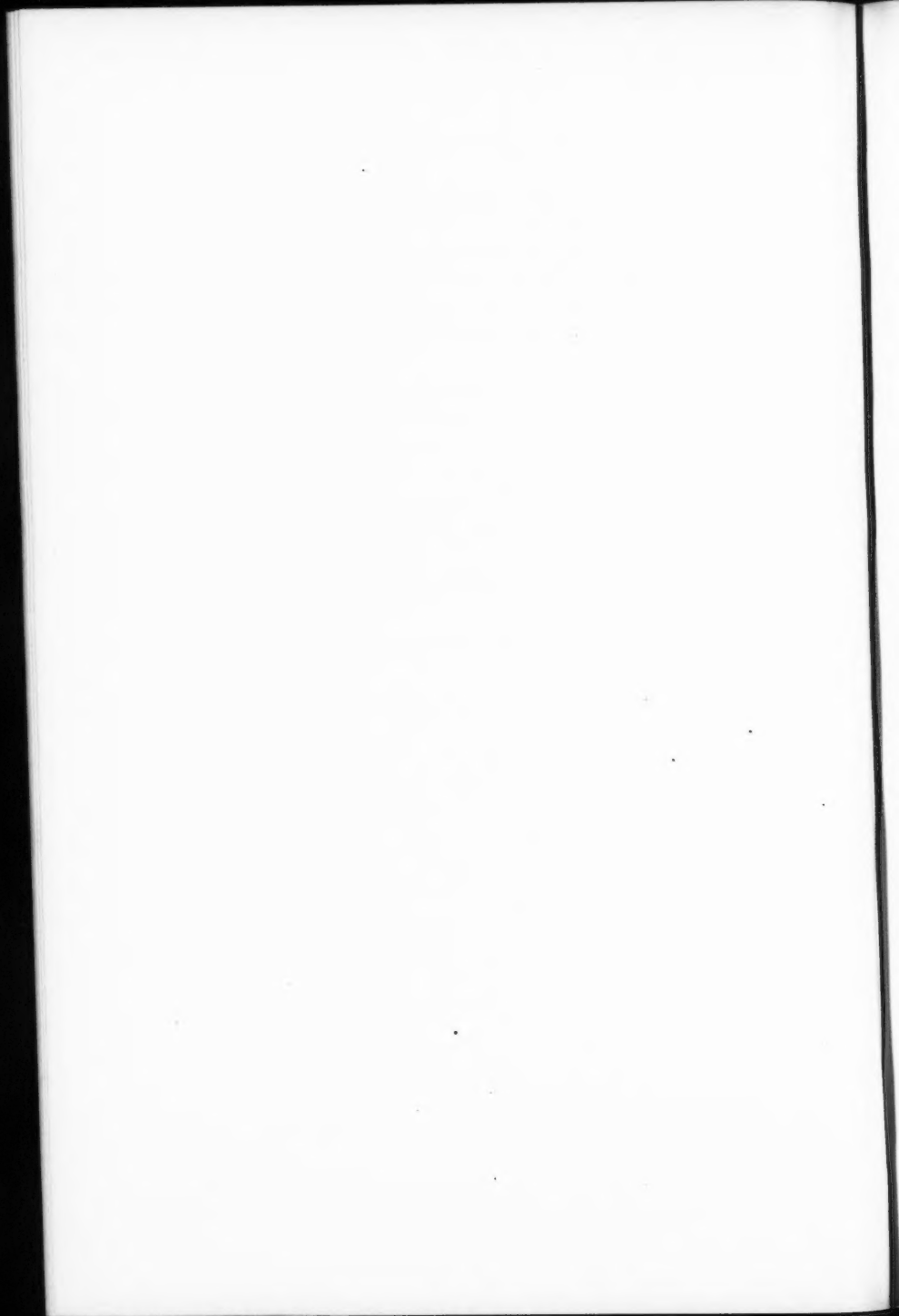
eggs. The average yield of eggs is $4\frac{1}{2}$ ounces per dogfish, of a value of at least 1 cent per fish. Here is some glove leather prepared in Peabody with the dogfish eggs.* The only difficulty is that the leather is not as white as the leather prepared with hen's eggs, but nevertheless the tanners in Massachusetts are anxious to get the dogfish eggs at a reasonable price.

It was also found that the fins and tail of dogfish are used very largely by the Chinese, and we have had inquiries from Hong Kong as to whether or not we can ship shark fins and tails to Hong Kong and Singapore. They have gone so far as to send us samples which they say are satisfactory, and I judge from the odor that the preparation of dogfish fins and tails would be relatively easy. They are also used in making soups of a gelatinous character. The value of the dried fins and tail, prepared with salt and sugar, is about 20 cents per pound retail, or a value of 5 to 20 cents for each adult dogfish. The total value therefore of oil, fertilizer, eggs and fins is not less than $11\frac{3}{4}$ cents per fish and may easily double this amount.

The question of the utilization of dogfish depends on the question of bringing them into port. Fishermen refuse to bring them in at present. We are now endeavoring to make a market by which the fishermen can bring the fish to definite places for utilization. But that is difficult, for no manufacturer will equip a plant until assured of a definite supply of dogfish. We asked a fisherman to bring in a few dogfish one day, and he brought in 1,800 pounds instead of 50 pounds; and then for several days we could not get any. So the manufacturers are unwilling, until they can find a definite and regular source of dogfish supply to equip their factories for the purpose. We have suggested that a power vessel might be profitably employed to collect the dogfish from the vessels on the fishing ground, *e. g.*, South Channel, or Georges, and bring them to the factory, or even have

*The speaker exhibited a fine specimen of tanned and prepared sheepskin, though of a slightly yellow tinge.

the vessel equipped with a small rendering plant to operate at sea near the fishing fleet. But we are rather hopeful of a solution from the fact that a fleet of otter-trawlers is developing in Boston harbor. There are at present four, and at least two more will be launched soon. The question is whether these otter-trawlers, which catch a large quantity of dogfish may not find it profitable to bring them in either entire or in part, *e. g.*, livers, eggs, fins and tail. The otter-trawlers are very much opposed by the general fishermen and vessel owners, who believe that they will destroy the fishing grounds, as it is claimed that they have done in the North Sea. If, however, it can be shown that the otter-trawlers can be used for destroying these dogfish and placing them on the market, thus cutting off an enormous economic loss to the fishermen, possibly there will be a better feeling between the old line fishermen and the otter-trawlers.



NOTES ON POND CULTURE IN THE PHILIPPINES

BY LEWIS RADCLIFFE

The islands of the Philippine Archipelago lie wholly within the tropics. The land area extends north and south 1,150 miles, east and west 650 miles, and comprises more than 3,000 islands with a soil area of nearly 128,000 square miles, or about one-sixth of the total area. The water on the wide plateau on which the islands stand is relatively shallow, much of it being less than 200 feet deep. Notwithstanding the excellent opportunities afforded the salt water fisherman, pond-culture holds a most unique and important place, ranking in capital invested and output as one of the most important fisheries of the islands.

Pond-cultural operations have been carried on in the region about Manila for at least half a century. The ponds are confined mainly to the lowlands adjacent to lagoons and tidal streams, lands of little or no value for other purposes. The principal region lies around the shores of Manila Bay. Its ponds alone are valued at more than \$3,000,000* and it is with the methods used here that the present paper deals. In the province of Bulacan alone, the governor reported in 1908 nearly 15,000 acres devoted to these operations.

The ponds are simple excavations of varying size. Some of the larger cover several acres and are often subdivided, each subdivision having a specific function. Two small ponds near Cavite, 35 by 58 and 30 by 120 feet, united with one another by a sluice and with a neighboring stream by a narrow supply channel, had been built at a cost, including masonry, of less than \$50.

The following description of one of the larger ponds near Manila will serve to illustrate this class. It was 600

* An estimate made by Mr. Wm. D. Carpenter, who has given the study of the methods used in the Philippines considerable attention and to whom I am indebted for corroboration of a number of doubtful points and for some additional ones.

by 1,200 feet, with a strong earthen retaining wall and was subdivided as follows: 480 feet from the upper end had been built a low cross-embankment with a sluice gate near one end; 600 feet farther down was a similar wall and gate; the narrow strip at the lower end was subdivided into two unequal ponds, the larger opening into the adjacent large pond and also into the small one, the latter also into the large pond and by an outlet into the neighboring river. The two large ponds serve as the main stock ponds; they may be used in conjunction or separately. The third is used mainly for holding the young fry until they have reached sufficient size to admit of their introduction into the main ponds; the smallest serves as a control and as a place for catching the fish. The water level is controlled by wooden gates fitting into masonry and is normally kept from three to five feet deep. Whenever desired, much of the water is drained off at low tide and the pond refilled by the incoming tide. Screens of closely woven hemp fibre (sinamay), closely woven bamboo mats and the like are used to prevent the fish from escaping.

The ponds require but little care. If they are in need of cleaning the water is drawn off and natives armed with pieces of boards scrape down the soft mud and force it out with the outgoing current into the river.

Attempts at artificial propagation of fishes have proved unsuccessful; instead the ponds are stocked each year with young fish taken from the sea. The milkfish, *Chanos chanos* (Forskäl), possesses to an exceptional degree the characteristics needed in artificial cultural methods and is practically the only species planted. Many others (mullets, gobies, eels, species of *Ambassis*, *Elops*, *Megalops*, etc., and a shrimp) find their way into the ponds and add to the total output.

The milkfish is a pelagic form. It spawns in the shallow water near sandy beaches. From April to August, the young may be caught in the surf near these localities. They are most abundant in May. A strip of coarsely woven

hemp fibre made into a square scoopnet or a rectangular piece of the same material used as a seine serve to catch the fish. The fishermen wade parallel with the beach, dragging the net near the surface and straining out the young fry. These are placed in earthenware vessels holding five or six quarts, two or three thousand fry in each.

The catch is transported with all possible haste to the ponds and disposed of at varying prices depending upon local conditions, size and abundance of fish, distance from fishing grounds, weather conditions, etc. The number of fish in each vessel is estimated by holding one valve of a clam shell or a small white earthenware dish below the surface of the water. Against the white surface the larval fish become visible and the number swimming above it noted. If buyer and seller fail to agree, the laborious process of counting at least a part of the catch is resorted to. For recording the count small pebbles or the shells of a small univalve, divided into lots of a hundred each are used. The fish are immediately planted in the smaller ponds.

The following records of fry planted indicate roughly the number of fish the ponds are capable of supporting. In one pond 60 by 120 feet, 600 fry were planted; in two ponds 35 by 58 and 30 by 120 feet, 1,500, and in a series covering about six acres 150,000 fry were planted annually. When the ponds are to serve as temporary retainers five to six times this number may be planted. Some of the owners of small ponds use them for this purpose alone, purchasing their stock for from \$1 to \$3 per thousand and selling later at \$10 to \$40 per thousand.

As the fish kept in this manner are largely dependent upon the tide for food, their growth is often considerably retarded. With an abundance of food in ponds not overstocked, their growth is exceedingly rapid. Thus a fish $\frac{3}{5}$ of an inch long planted in April, may reach a length of a foot by August, 16 inches by November and 18 inches the following March. The fish feed upon one of the algæ (*Edigonium*). This grows best in shallow pools of still

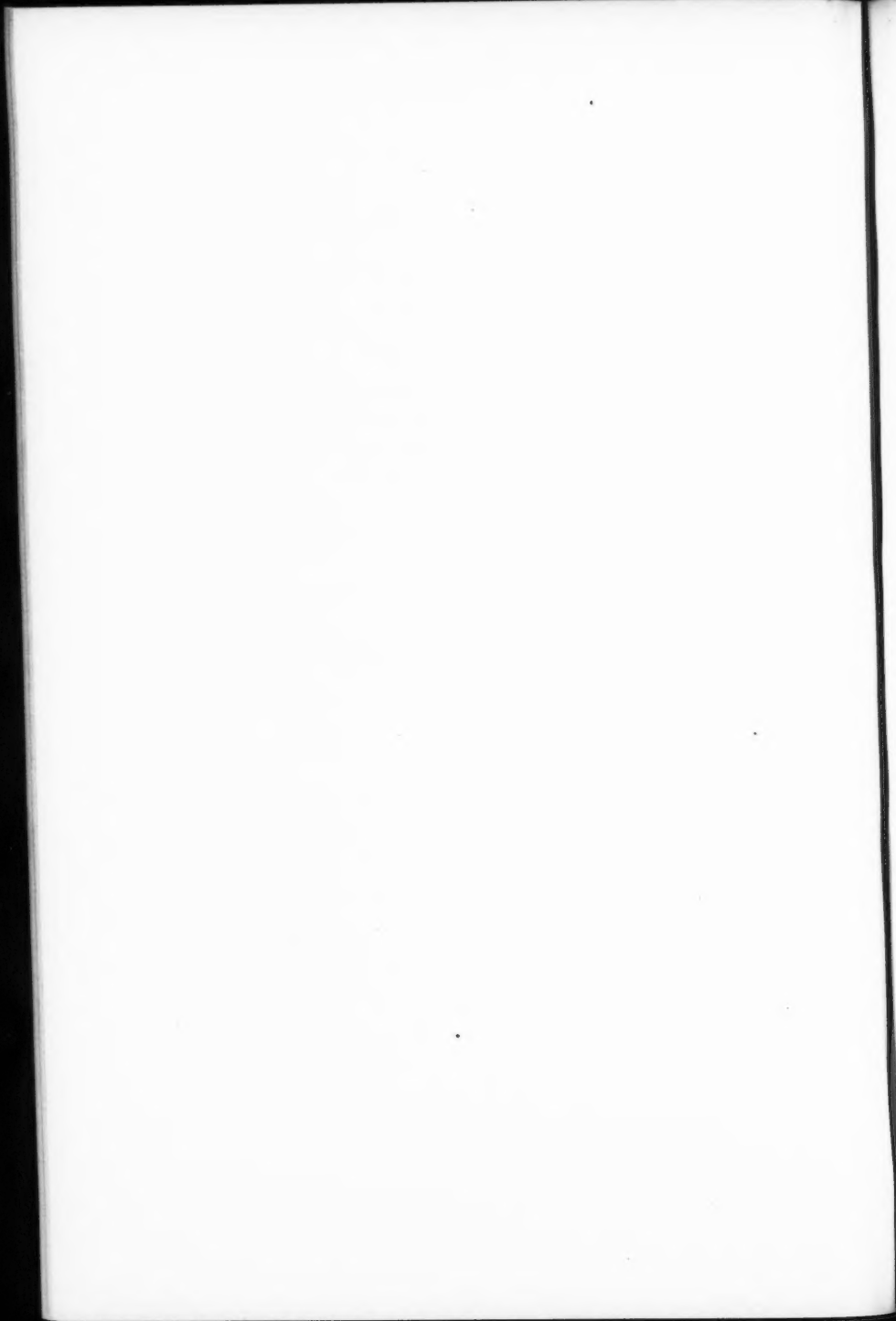
water. To encourage its growth in the ponds they are drained and refilled as fast as the growth of the algæ permits.

After remaining in the small ponds for about eight weeks, the young fish are introduced into one of the larger ponds. Under the new conditions they grow very rapidly. As soon as the *Edigonium* becomes scarce the fish are admitted to another pond, the former is then drained and the rapid growth of a new crop of algæ encouraged. When the fish are about five months old, the owner may begin harvesting his crop, selling to keep his ponds from becoming overstocked, or according to the demands of the market or his own financial needs. During the Lenten season the fish are in greatest demand and bring the best prices. At this time the balance of the stock is usually sold, preparatory to restocking.

Several methods of capturing the fish are in vogue; the water may be drained off and the deeper pools fished, or, the water level having been lowered and the tide outside arisen, the gates may be opened, setting up a strong current into the ponds, when the fish swimming against the current enter the small control pond from which they are easily taken. To satisfy a certain demand from those who wish to eat the entire fish, eight to twelve hours before making the catch the fishermen wade about in the ponds, beating the water to frighten the fish as much as possible. This causes them to cease eating until after the catch for market has been made, the stomach then being comparatively empty.

About nine-tenths of the people of the islands use fish as their principal flesh diet. Practically all fishes over an inch in length, and not considered actually poisonous, are eaten. Whenever there are storms or typhoons, many of the salt water fishermen are unable to operate their nets, fish their traps or send the catch to market; at such times the market is almost entirely dependent upon the catch from the ponds.

The milkfish is a bright, silvery, wholesome looking fish whose flesh is relished by native and foreigner. Its growth is very rapid under the artificial conditions in the ponds. These factors combine to give the cultivation of pond fishes a very important and profitable place in the fishery industries of the islands. With greater co-operation among pond owners against losses from flooding; with better methods of securing, transporting, and caring for the fry; with more scientific knowledge as to the habits and care of the species under cultivation; and with improved marketing facilities, this industry may be made to outrank any of the island fisheries.



THE TAXATION OF OYSTER PROPERTIES

BY HENRY C. ROWE

The subject of the taxation of oyster properties has recently received much attention from legislators, state officials and other persons more or less acquainted with the oyster industry. It has been under consideration in several states, and doubtless will be in others soon. In Connecticut the General Assembly has had before it over twenty bills affecting oyster matters during the past eight months, and there have been extensive hearings and discussions. Prior to that, for two years the subject was under investigation by a commission. In this discussion many propositions have been urged and answered, and the disproved assertions and superficial opinions have been discredited and rejected. In this paper I shall briefly state the results. The facts can be easily verified, and I hope that the deductions will be obvious.

The oyster growers in Connecticut, and so far as I know, elsewhere, make no objection to paying their just share toward the expense of government as other citizens pay upon other classes of property. How then shall this share be ascertained and fixed? The decision has been reached that where perpetual franchises have been granted to individuals for the propagation and culture of oysters, it is reasonable that these franchises should be assessed at their fair market valuation, and should pay such a rate of percentage of taxation as is proportionate to the protection of law which they receive.

The tax commissioner of Connecticut, after investigation, recommended that all cultivated oyster grounds should be assessed at an equal or flat valuation, and asserted that the clerk of shell fisheries, whose duty it has been to make these assessments, is not competent to assess them at adequate valuations. A practical oyster grower was, however, called upon to make these assessments, and according to the

report of the tax commissioner, this oyster grower increased the assessments on the average about 250 per cent, so that the tax paid to the state, since that assessment, was increased from \$11,000 per year to \$26,000. It was thus shown that one who is qualified to do so, could adequately assess the ground, in fact, some of the grounds were greatly overvalued in this instance. The Connecticut Legislature decided that it would be grossly unfair and inequitable to assess the grounds owned by A at the same valuation per acre as those of B, when in fact B's ground was worth one hundred times as much as A's.

As to the rate of taxation, it has been, in Connecticut, since 1893, one and a half per cent of fifteen mills on a dollar of valuation. A proposition was made to increase this rate to $17\frac{1}{2}$ mills, but the General Assembly rejected this proposition, because $17\frac{1}{2}$ mills on the dollar is as much as the taxation in many cities and boroughs, which in those cases pays for fire protection, street lighting, police, schools, sanitary regulations, and many other benefits which are not, and could not be extended to oyster grounds. For instance, it is clear that oyster ground covered by 20 to 40 feet of water is in no need of fire protection, street lighting or paving; but there is no other property which is so exposed to depredation, because oyster grounds are situated under navigable waters which are a public highway for every kind of vessel and boat by day and by night; also these oyster beds are usually situated remote from protection, except such as is especially provided.

In the case of those states where the ownership of the oyster grounds is retained by the state and they are leased to propagators and planters of oysters, it would, of course, be unreasonable to lay any tax upon the grounds which in fact are owned by the state, and for which the planters pay whatever rental is established by the state before their leases are taken. The owner and landlord should pay the taxes, and not the tenant.

There are some minor considerations which have been urged with reference to the preceding questions, but when adequately answered the result remains the same, hence I will not in this paper take them up in detail.

There remains another question which has been raised occasionally during the past thirty years, but which has always been answered in the same way. In Connecticut there has recently been a very extensive discussion and contest over this question; whether oysters propagated, planted and grown upon the private cultivated grounds should be taxed. On public beds, where the state owns the grounds and the oysters grow naturally without artificial propagation and cultivation, it would seem to be optional with the legislature whether the state should derive a large or small income from the natural product of these grounds. This is done in some instances by charging a license fee to those who derive the benefit of catching the oysters and shellfish upon these grounds. The rights of all citizens of the state are equal in these shellfish, but it is obvious that it would not be practicable for all the citizens of the state to share in the products of these grounds, when special equipment is necessary in order to take the oysters, in some cases costing from \$500 to \$2,000 to each vessel used for the purpose.

In order then that all the citizens of the state should partake equally in the benefit of these grounds, it has been shown by those officials who have made this subject a study that either these grounds should be sold or leased to individuals, or else that those who have the exclusive privilege of working upon these grounds, by reason of equipment, etc., should pay for suitable licenses to produce a reasonable revenue to the state for the privilege which they enjoy.

The question as concerns oysters artificially propagated and grown upon the private oyster grounds, which are owned by individuals practically in the same way that real estate is owned on land, is an entirely different question, and is analogous to the crops of corn, wheat or cotton, or other crops which are grown upon the land. It is not considered

public policy to tax the growing crops of the farmer, and there is no reason why any different rule should be applied to the crops which are grown upon oyster grounds. There is perhaps even some additional reason why oyster crops should not be taxed. They are exceedingly hazardous, and no oyster planter knows whether he will secure a crop, half a crop, or less than half a crop until after his oysters are harvested. Oysters are subject to partial or total loss from the effect of great storms, from the ravages of the drill, from destruction by starfish, from being stolen by reason of their exposed situation, and by other causes. There are few crops, if any, on land which are subject to so great hazard as are oysters. Moreover, they are from their situation very poorly protected by lawful authority. Therefore, it would be unjust to discriminate against oysters as compared with other crops for the purpose of taxation.

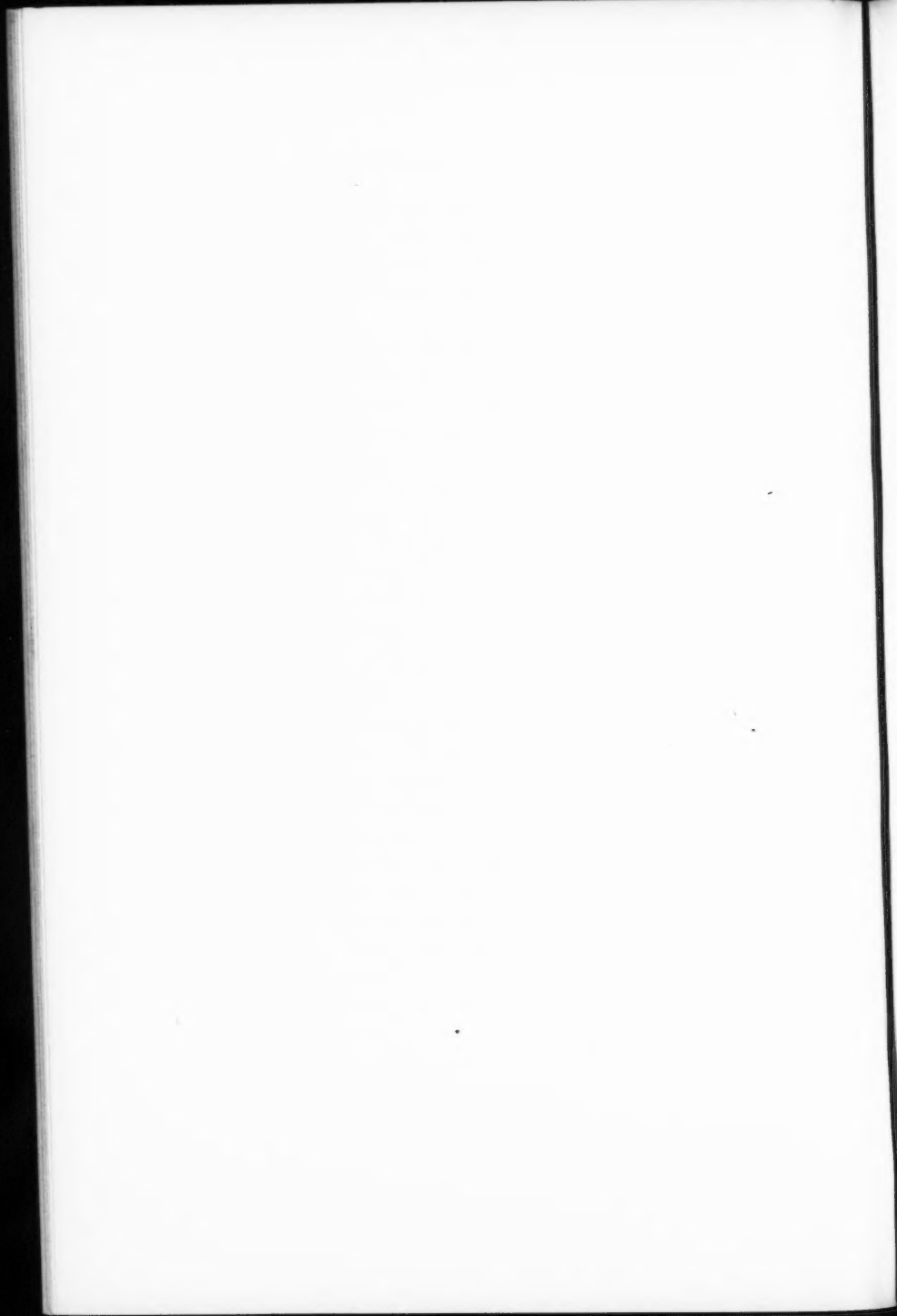
It is not public policy to lay a tax upon the product of the manufactory or of the farm on land, nor of the oysters produced on the oyster farm under water. It has been one of the principles which has prevailed in our revenue-producing legislation for a long period that taxes should be laid in such a way as to protect and foster our industries, but whether this be well founded or not, it is obvious that it is not public policy to reverse the principle by taxing growing crops, thus penalizing industry and enterprise. This question has just been considered at great length by the Connecticut General Assembly, and has been so decided.

There is another consideration which ought to be mentioned, namely, that the United States Government, and many of the states, propagate swimming fish and furnish them without charge to the fishermen who make a business or sport of catching them. This privilege the fishermen enjoy, in most cases without expense to them, and it would be unreasonable to penalize by taxes the oyster grower, who by great expense propagates oysters upon grounds which he has bought or leased from the state, on terms made by the state itself, while at the same time the United States and the

states are furnishing without cost the swimming fish for the angler. In many countries a bonus is paid by the government to encourage fishing on the high seas, although the fishermen in such cases contributes nothing toward the propagation of the fishes.

The growers of oysters throughout the United States pay the same taxes upon their steamers, vessels and boats, upon their docks, packing houses and all their equipment, as any other citizens do upon their property. They also pay taxes upon their product just as soon as it is marketed, in one form or another. The proceeds of their crop is immediately used in their business, in wages, for equipment, or in investments for land, steamers, real estate, or in some other form, and this at once becomes subject to taxation the same as other property through the regular channels and methods. While the oyster crop is growing it ought not to be taxed, unless growing crops on land are taxed, but as soon as it is marketed, it is subject to taxation, the same as any other property.

Desiring that this paper should not become too long, I must not diverge into the minor branches of this subject, but would repeat that oyster growers pay cheerfully all the taxes which are reasonable and equitable, but protest against the application to their industry of exorbitant and unusual methods of taxation, which have not been, and will not be imposed upon other industries which are more strongly represented in the legislative bodies, and are consequently able to protect themselves against injustice.



REGARDING FISHWAYS AND DAMS

By L. L. DYCHE

Section 23 of the Kansas fish and game law (chapter 198, Laws of 1911) provides that "no dam or other obstruction across any river, stream or other waters in this state shall be erected or maintained which is not provided with a proper chute or fish ladder of suitable capacity and facilities to afford a free passage for fish up and down the same while the water is running over such dam or obstruction; such chutes or fish ladders shall be of such construction and material as shall be prescribed by the state fish and game warden, and shall be completed and placed in all dams in existence at the date of the passage of this act on or before the 1st day of November, 1911, and all dams built after the passage of this act shall be constructed with such chutes or fish ladders at the time of building of said dams."

A recommended design for such fish ladder as is contemplated in the fish and game law is shown in detail on the accompanying drawing. In addition, the following suggestions are made regarding the construction and maintenance of this form of fishway.

The ladder is to be placed in the principal channel of the stream or where the deepest water is to be found. Especially the bottom of the ladder must be in some permanent pool of the main channel.

As shown in the drawing, a channel or notch must be cut across the crest of the dam sufficient to receive the full depth of the ladder. In the case of masonry or concrete dams, anchor the ladder substantially to the dam crest by means of strap irons and anchor bolts. In the case of a timber dam, cut out a recess for the fishway the same as for a masonry dam, and fasten the strap irons to the principal timbers of the dam crest by means of bolts or long lag screws.

Build the ladder of sound and durable two-inch planking, of as long lengths as it is possible to use, and of the widths shown on the drawing. Make all longitudinal joints over the steps or baffles of the ladder. Bolt together thoroughly at the junction of the horizontal part of the ladder with the inclined part. This junction should be reinforced with wide iron plates as shown, as this is the weakest place in the structure. Use plenty of spikes throughout the entire construction.

The drawing shows the inclined part of the ladder supported and held in position by a framework loaded with rock. A better means of support would be masonry piers in case the bed of the stream is rock or ledge, or pile trestle bents in case the stream bed is soft. Whatever the method used, the supports should be of such a character and should be near enough together to securely hold the ladder in place against the uplifting force of the water during floods.

The upper and lower ends of the fishway must be kept clear of all mud and drift and other debris, and open to the passage of fish. In case sticks or stones are washed into the fishway and become lodged in the pockets of the baffles, these should be removed by hand through the openings between the cover planks.

The cost of the structure will depend, of course, on the height and character of the dam and other local conditions. No general estimates can be made, but the following bill of materials required in the case of a masonry or concrete dam five feet wide on the crest and with a difference of eight feet between the water level above and below the dam, may be given as an example. In this it is assumed that the pool below the dam is four feet deep and that three supports like that shown in the drawing are required:

For fishway:

- 438 lineal feet of 2 in. by 12 in. planking.
- 225 lineal feet of 2 in. by 10 in. planking.
- 2 bent iron plates 16 in. by $\frac{3}{8}$ in. by 5 ft.
- 2 iron straps 3 in. by $\frac{1}{2}$ in. by 7 ft.
- 8 anchor bolts $\frac{3}{4}$ in. by 12 in.
- 40 bolts $\frac{3}{8}$ in. by 3 in. Spikes as needed.

For frame supports:

90 lineal feet of 2 in. by 12 in. planking.
 18 lineal feet of 2 in. by 10 in. planking.
 60 lineal feet of 6 in. by 6 in. timbers.
 68 lineal feet of 4 in. by 4 in. scantling.
 12 bent iron plates 4 in. by $\frac{1}{4}$ in. by 12 in.
 3 iron straps 6 in. by $\frac{3}{8}$ in. by 9 ft. 6 in.
 6 bolts $\frac{5}{16}$ in. by 11 in.
 6 bolts $\frac{5}{16}$ in. by 16 in.
 18 bolts $\frac{5}{16}$ in. by 9 in.
 Spikes as needed.
 Rock for piling in and around supports.

Estimated cost of material for the above structure:

Lumber	\$52.00
Iron work and bolts.....	35.00
Spikes	12.00
Total	<u>\$99.00</u>

This fishway may have as many twists and turns as a stairway, and may be built anywhere over the dam where the depth of the water would be sufficient. It may even be built around one of the end abutments. The slope of one foot to five must, however, be preserved. In practice, some of these fishways have been constructed of cement, others of steel, and others of a combination of these materials.

DISCUSSION

MR. G. H. GRAHAM, Springfield, Mass.: I am very much interested in fishways, and I would like to ask Mr. Meehan or Professor Dyche, or anybody else, if there are any fishways which will permit of the fish going up, and in that respect are they a success?

MR. MEEHAN: I can speak of the matter so far as a fishway that is in operation by the state of Pennsylvania is concerned. It is a fishway designed in the first place, I believe, by some one connected with the Bureau of Fisheries, at Washington, and adopted by the United States Government, also adopted by Pennsylvania; a device known as the Cail fishway. It has been very effective in the waters of Pennsylvania. Last summer, while inspecting one of these fishways, I drew the water off. This fishway was 300 feet in length, and the character of the dam was such that it was impracticable to follow the specifications exactly in its construction. This dam was one of the largest in the world, 60 feet high and about 50 feet thick at the base. The consequence was that the outlet of the fishway had to be something like 200 feet away from the toe of the dam in order that it might be submerged at low water. It was a double fishway, too, and with double width to every compartment. From the bottom to the top it was simply packed with eels, thousands upon thousands of them. There were also thousands of yearling and larger sized sunfish. Several bass were found in the compartments and one or two pike-perch, showing that the fish would go up those fishways.

The same fishway was placed in a large trout stream in Tioga County, where the dam prevented the fish that had gone down in the spring from going up above again along about September. The pool below the dam prior to the erection of the fishway was always packed with trout and very few large trout were ever caught in the water immediately above the dam. But after the building of the fishway many large trout were caught, and trout were seen, according to reports to the office, going through the fishway.

We found, however, that shad would not go through such fishways unless they were very low. In one dam on the Susquehanna River at Clarks Ferry, we had four of those fishways and, prior to that time no traces of shad were found above the dam; but the following year some dead spent shad were found in the west branch of the Susquehanna near Williamsport. Also in some nets that we found on the north branch of the Susquehanna about 50 miles above there were a number of young shad. But we must say that our experience with fishways and shad has been rather disappointing. Shad apparently are afraid to go through them.

The fishway itself consists of a series of compartments or boxes; the bulkheads forming the compartments are provided with openings on alternate sides, and only of sufficient size so as to cause some of the water to flow over the bulkheads, thus allowing the fish to either pass through said openings or over the top of the bulkheads. So far as

the fish other than shad are concerned they have been successful in Pennsylvania.

MR. GRAHAM: I referred especially to shad. There is a great field for some inventive mind, because no one has as yet invented a means whereby the shad will go up.

MR. MEEHAN: During the last few months of my tenure of office I was bitterly criticised for putting in a fishway at this dam 60 feet high, which was "utterly useless because the shad would not go through." Possibly it might be interesting to know that on the York County side of the dam—the right bank of the Susquehanna—is a pile of rocks that reaches within 10 feet of the crest of the dam. We noticed last spring that there were two or three pools in the river formed by a series of rocks, and a number of shad succeeded in getting to the topmost pools, or within 10 feet of the crest of the dam. I got in communication with the company owning and controlling this big dam (McCall's dam); and when I went out of office they were preparing plans for an artificial series of rock pools to be made clear to the crest of the dam; so that the shad could reach one pool from the other. We had hopes it would be effective in letting some shad at least go up into the river above. There was a fair prospect of it at any rate, from what we had seen.

SECRETARY BOWER: Just a word anent the Cail fishway, of which mention was made. After many years of experimentation and investigation, the Bureau of Fisheries has adopted what is known as the Improved Cail Fishway. The original Cail fishway has been modified by Mr. Hector von Bayer, the architect and engineer of the Bureau of Fisheries. Whenever he receives any communications on the subject the interested persons are referred to this particular form. It is described in a pamphlet issued by the Bureau about two years ago. Drawings, blue prints and directions are furnished on application.

MR. W. O. BUCK, Neosho, Mo.: There is a fishway on the Penobscot at Bangor designed by Mr. Atkins, which he told me was examined at one time by himself and the state commissioners and found to contain salmon in every pool. It is intended especially for salmon and consists of a double spiral of pools on the plan of the Cail fishway. He considered it a success for salmon.

At the head of a branch of the Penobscot in the town of Orland there was a small fishway to enable alewives to pass a dam some twelve feet high, arranged on somewhat the same principle, that is, in pools; being a narrow sluice divided by transverse partitions having openings on alternate sides of the sluice by which the water fell from one pool to the next. Both of these I understand to be of the Cail fishway pattern.

Mr. Atkins' article on fishways published in one of the earlier reports of the U. S. Fish Commission—I think that for 1878—was a very complete summary of all the fishways in use at that time. The article would be a valuable reference in studying different styles of fishways.

DISCUSSION OF FISH-CULTURAL CONDITIONS AT FOREST PARK, ST. LOUIS, WITH SPECIAL REFERENCE TO THE PROPAGATION OF BLACK BASS

MR. S. G. WORTH, Mammoth Spring, Ark.: Mr. President, if I am in order, I would like to make an allusion or two to the visit of members of this Society yesterday at Forest Park. I wish to say that I found great pleasure in this visit, and I learned something. I was really surprised to see so large a number of fish, and it is a confession, not to my discredit I hope, although I am in the same line of business for the Bureau of Fisheries at Mammoth Spring, to admit that if this Society had visited that station yesterday in place of Forest Park, it would not have seen such a display. I believe in the motto of giving credit where credit is due, and I wish to say emphatically that I was delighted and surprised at the great quantity of fish seen.

These fish had an extraordinary amount of shore line, and in my short experience with the black bass, I had already come to the conclusion that to make black bass culture a success, that is, in rearing the fish from fry up to fingerlings of 2, 3 and 4 inches size, that which is needed—an element that is essential—is a quantity or great amount of shore line. The young appear to feed right around the shores, and at Forest Park there seemed to be a very large percentage of shore line in comparison with the pond area. I am referring now to the ability of the young fish to find their food. They feed in the shallow water.

When I made similar remarks yesterday at the park, some gentleman at my elbow said, "And it gives a tremendously increased spawning area." So that there would seem to be an additional advantage.

The presence of goldfish in the pond struck me as being a valuable thing. My observation of the goldfish at the Mammoth Spring station is that they are propagating all through the summer and in great numbers. I believe that the bass at Forest Park are in such nice condition and are so numerous, because they have quite an amount of food derived from the young goldfish. It is very evident there is a large food supply. I cannot guess what it is, but I think unquestionably that the goldfish contribute largely to it. I believe it to be a good plan to put goldfish in the rearing ponds to produce food for the young bass.

MR. W. O. BUCK, Neosho, Mo.: Let me add a word for the purpose of getting on record something of what we saw at the fish pond in the park,—and I wish much more in regard to it could be put in our records.

Our conductor told us that the brood fish were put into the pond absolutely in pairs. Now those of us who have handled bass know that in that case they must have been put in very shortly before their spawning period, because it is practically impossible to distinguish the sexes much earlier. Then he said that they were removed from the pond

immediately after spawning, about May 15, and further that the young fish were immediately assorted as to size, also as soon as they became large enough they were assorted twice a week.

These four points will be of importance to every one interested in bass culture, and the only way to get them before those who are not present is to put something in our record, which is my excuse for drawing attention to them now.

MR. MEEHAN: Gentlemen, this matter of bass culture is one of very great importance, and, curiously enough, there have been no papers presented at this meeting on that subject—the first time in many years within my knowledge—and I am especially glad this matter has been brought up now, because I think it is important that we should have something to say about bass culture, large and small-mouth bass culture or both.

One thing in the utterances of the first speaker about the condition of things in the pond yesterday, I would not have missed for anything. The fish were in splendid condition; they could not have been in finer condition; I never saw finer fish for their age. I feel, therefore, that we should go into this matter and have further discussion on the whole question of the bass. Dr. Bean, I think you can perhaps tell us something of very great interest in regard to this matter of bass.

MR. WORTH: If Dr. Bean will give me a moment I want to say that in my remarks I mentioned Forest Park, but not the Missouri State Fish Commission or the gentlemen who have had the honor to do that excellent work out there. I think that in the proceedings that point ought to be mentioned. I do not know the names of those gentlemen, but I suppose the work is being done by the Missouri State Fish Commission.

MR. MEEHAN: That is right, the Missouri State Fish Commission.

DR. TARLETON H. BEAN, Albany, N. Y.: Mr. President, I do not know how many of the state commissions would be able to profit by the experience of New York, but I think it ought to be a matter of record that in our state we take advantage of the spawning season of the alewife, which we get in the Hudson River during the shad season. The alewife is so accommodating that it arrives at our hatching station at just the right time, and continues to grow in just the right ratio of progression to bring our bass to the same condition in which these splendid bass in Forest Park were found yesterday. Without intending to boast, I think that New York has as fine small-mouth bass as any other state, and it is due to the opportunity to get alewife eggs at the proper time.

Then Nature has done something else for us in New York which I presume she is also doing in other localities. We have the black fly which on entering the larval stage collects on the slash-boards of our pond outlets in such enormous quantities that the little bass generally gorge themselves, so that one can almost see them grow. I have really been astonished coming down to that bass station week after week to note the rapid strides that the bass were making.

With the alewife and the black fly larva we do not have to feed our bass anything. Nature does it for us, and still we have the most beautiful bass—they are as fine as the bass in Forest Lake—and we feel very happy over it. I believe that any state having access to alewife fisheries can undoubtedly utilize the alewife eggs in that way.

We also propagate shad at that same station. We take about 8,000,000 shad eggs at Rhine Cliff, which is some 20 miles below the point at which they were taken in the time of Seth Green, 35 or 40 years ago; but still we take them and we are getting almost as many every spring as were collected at Castleton 40 years ago. Of course we hatch those eggs, and in getting them we obtain also alewife eggs. We get from 50,000,000 to 100,000,000 during the season, giving us an ample supply for our ponds.

Then we rear some shad. The shad appear to find in these ponds daphnia, cyclops and other little crustacea in enormous quantities. Our ponds are not large, but are well arranged, have both shallow and deep areas, with plenty of aquatic plants; so that the insect and crustacean life is attracted to the ponds, and the fish get the benefit. The shad grew this year to a length of 6 inches up to the time when they were liberated; and they were fed only on cracker dust, just as the Connecticut Commission used to do. We planted about 100,000 at one time from 3 to 6 inches in length.

MR. WORTH: I would like to ask Dr. Bean what the scientific name of that black fly is, so that we can look it up.

DR. BEAN: It is a species of *Simulium*. I have the specific name, but I do not remember it offhand. It is one of the black flies. The little bass are so fond of this larva that they will actually swim all over the hand of the attendant feeding them. They lose their fear, although the young bass is a pretty shy fish; they come and seize deliberately, without fear, every larva that can be taken off the attendant's hand.

MR. MEEHAN: What is your method of breeding this larva?

DR. BEAN: We do not have to do that at all. It comes into the ponds every year. The only thing that we add to the pond is the alewife fry.

MR. MEEHAN: Are the eggs deposited on the edge of the ponds?

DR. BEAN: Yes.

MR. MEEHAN: And then as they hatch the larva falls into the water?

DR. BEAN: Yes; and they collect on the slash-boards of the pond outlets. The attendant simply goes there, and with his hand or a dipper takes out a handful at one movement; they are then given to the bass in the usual way.

MR. MEEHAN: If it became necessary or desirable to introduce this fly for such purposes, would its culture be difficult, or haven't you looked into that feature?

DR. BEAN: No, I have not. We have not had occasion to introduce it, because it is always there. The same thing is true at Constantia.

where we rear the most of our black bass. We have there practically the same species of black fly. The men thought they were worms at first, but the bass knew what they were and what to do with them.

MR. MEEHAN: Is the fly itself a nuisance?

DR. BEAN: Not at all.

DR. S. A. FORBES, Urbana, Ill.: I can answer some of the question asked concerning *Simulium* or black fly. We have, in fact, been making special studies of this insect along the Illinois River during the last two years, taking the subject up at the request of the Pellagra Commission of the State of Illinois because the black fly has been suspected by physicians of being concerned in the conveyance of pellagra from person to person.

Black flies are common all over the country wherever conditions are fit for their multiplication. They must have running water with a considerable current, and will not breed in stagnant or sluggish water. We find the larvæ, for example, in the larger rivers of the Mississippi system only where there is something to arrest the current and create a ripple over an obstruction. Where a mass of drift-wood becomes packed together in a way to check the movement of the stream, the surface of this submerged wood will often become black with these larvæ, which hatch there by myriads, and can perhaps be found nowhere else in the stream. The adults thus become an enormous nuisance, the fly itself being a pestiferous creature, as violent as a bee and as persistent as a mosquito.

You will see, consequently, that if you want to get black fly larvæ to feed to young black bass, you must have some such conditions as I have described; that is, shallow water with a freely flowing current in which the larvæ can live. They apparently require a certain degree of aeration of the water which they do not get in stagnant situations.

MR. MEEHAN: Does the black fly actually convey the pellagra disease? That would be rather interesting to fishermen, because if it did there might be some hesitation about introducing it.

DR. FORBES: Perhaps I ought not to have mentioned that matter, because it is a point still under discussion by physicians in this country. Most of those who have investigated it seem highly skeptical of the theory that the *Simulium* gnats are agents in the transmission of pellagra. That idea sprang up in Italy, where one of the great authorities on insects as carriers of disease, Dr. Sanbon, of London, was investigating the cause of pellagra. He came to the provisional conclusion that in Italy the black fly conveyed the disease; and our people in this country then took the subject up. We have worked with it for two years in Illinois, particularly in neighborhoods where pellagra has shown up as a local disease, and we have failed to find any evidence that the black fly has anything to do with it.

DR. BEAN: I suppose there are a great many species of *Simulium*?

DR. FORBES: Yes.

DR. BEAN: I am quite sure there is no pellagra in Columbia County,

New York, and never has been, nor in the Adirondacks where other species of *Simulium* occur; but whatever the cause may be, the *Simulium* in Columbia County is not troublesome, but a boon to the fish culturist.

MR. BUCK: I would like to ask Dr. Bean to go a little more into detail in regard to the handling of alewife eggs. I do not have it quite in my mind whether he attempts to hold the young fish after hatching the eggs or not.

DR. BEAN: The alewife eggs are hatched in the McDonald jar or other good type of jar, where you can get a circulation of water. It is a very easy thing to do. They hatch in a few days and begin to grow. Our ponds appear to be full of the natural food which the herring family like. We may be more fortunate than others, but I doubt it very much. I believe that any state in which the alewife occurs may take advantage of the very same thing.

MR. BUCK: You put them into ponds soon after they are hatched?

DR. BEAN: Yes, we put them in the ponds as fry soon after they are hatched. Of course the alewife is very small.

MR. WORTH: I find this talk about the black fly very interesting, and would like to ask if it is the same as the buffalo gnat?

DR. FORBES: It is the same thing. They are different names for the same insect.

MR. WORTH: I wish to refer again to the large-mouth bass pond at Forest Park that we visited yesterday. A description of the nature of the pond I would like to have go into the record. One of the gentlemen present who is connected with this work said that during this summer they worked heroically to get the water moss out of the pond. Meanwhile he had gotten out of goldfish, but by some arrangement he secured adult goldfish from the Park Commission here and put them in, and he said that in a few days the water moss was gone—eaten by the goldfish. At the Mammoth Spring station last summer we spent considerable money to get the moss out; otherwise we would have gotten no young bass. It would appear from what he said that the goldfish pastured on the moss and destroyed it.

MR. MEEHAN: Was it chara moss that was in the ponds, or did you ascertain what it was?

MR. WORTH: I did not ascertain what kind it was.

MR. MEEHAN: The assumption would be that it was the chara moss.

DR. BEAN: No, it is one of the milfoils.

MR. MEEHAN: The goldfish could get away with that, but it is hard to understand how they could get away with the chara.

DR. S. P. BARTLETT, Quincy, Ill.: I desire to say that the superintendent of the Missouri Fish Commission is here, and he will be very glad to answer any questions. I have watched those ponds carefully for a number of years, and I want to say that I do not believe there is anywhere in the United States a state commission that has produced the same number of bass for the same amount of money, as has

resulted from the work of the Missouri Fish Commission. Added to that I must mention the intelligent work of the President, Mr. Geserich, who has given it a splendid business administration, something Missouri has not had for a good many years. The output has been simply fabulous. Mr. Kopplin, the superintendent, will be glad to answer any questions as to the management, food, etc.

MR. MEEHAN: I want to say that about a year ago the superintendent of one of the stations in Pennsylvania told me that he had found a very cheap and effective method of getting rid of algae in his ponds, something we were being bothered with a great deal. He did it by placing white and yellow catfish in the pond, especially the young—the advanced fry and fingerlings—and it was remarkable the speed with which they cleaned up the algae in those ponds. They caught them by the hundred and were very effective in doing it.

PROF. L. L. DYCHE, Pratt, Kan.: I would like to get some idea about the number of fish produced per acre. In our hatchery in Kansas for two years we have at considerable trouble counted the fish, and I would like to know what is considered a good crop of fish per acre.

MR. WORTH: I would like to ask one question: I would like to know what the algae is that has been spoken of, whether it is that floating, long, veil-like, green substance on the surface of the water, or whether it is the growing plant with roots down underneath the surface of the water.

MR. MEEHAN: We should be very glad to have Mr. Kopplin's experience in these matters.

MR. PHIL KOPPLIN, St. Louis, Mo.: It is a green floating algae, with the long stems. I believe the goldfish rooting along the bottom cause it to die. It is a short-lived plant anyway.

MR. MEEHAN: It is said here that you have placed in that pond 415 bass.

MR. KOPPLIN: Yes.

MR. MEEHAN: And they were exactly in pairs?

MR. KOPPLIN: Yes.

MR. MEEHAN: Put there last fall?

MR. KOPPLIN: This spring, just before the spawning time.

MR. MEEHAN: I was going to ask how you distinguish the sexes?

MR. KOPPLIN: I usually wait till just before spawning time, and it is easy then for the fishman to determine the sex.

MR. MEEHAN: The matter was spoken of here some time ago. One of the members spoke about it and understood that these fish were put in last fall and we were all interested to know how the sexes could be differentiated.

PROFESSOR DYCHE: In how many acres of water were the 450?

MR. KOPPLIN: Four and one-half acres.

MR. MEEHAN: Have you tested them as to whether that is the capacity of the pond for those fish or not?

MR. KOPPLIN: No, I have not.

MR. MEEHAN: What was your output last year?

MR. KOPPLIN: 70,000 to 80,000 fish, but a good many of them were distributed in the fry form.

MR. MEEHAN: Let me understand your expression of the word fry. What do you mean by that?

MR. KOPPLIN: The fry are those little fellows.

MR. MEEHAN: Less than an inch long where the sac is gone—advanced fry?

MR. KOPPLIN: Yes, about an inch long. Those fish out there were hatched about the middle of May, and by the 27th of the month you would find fish there an inch long.

MR. MEEHAN: Was that 80,000 you put out last year the average annual output from that pond?

MR. KOPPLIN: No, we have put out more than that from time to time, but it just depends with us on how the fish commissioners feel about the distribution. If they want me to hold the fish over until fall, we do not get that number.

MR. MEEHAN: How many have you put out from that pond this year?

MR. KOPPLIN: We made two trips with the fish car, and have taken out already about 50,000 fish.

MR. MEEHAN: What is your estimate of the number there now?

MR. KOPPLIN: About 40,000, that is as close as we can approximate.

MR. MEEHAN: What is the greatest number you have put out from that pond in one season?

MR. KOPPLIN: As most of these gentlemen who have had experience with young bass know, when they are swarming you can put out about the numbers you want. We have put out as high as 450,000 fish.

MR. MEEHAN: And those, of course, were nearly all advanced fry?

MR. KOPPLIN: They were all fry and advanced fry. They were distributed within a month after hatching.

MR. MEEHAN: You have never had anything, of course, but the large-mouth bass there?

MR. KOPPLIN: Some of the small-mouth have spawned there, but we never tried them to any great extent. I have just put the small-mouth in one of the small ponds to see how they will do, but we have never had much in the way of results, because our smaller lakes are not good bass lakes.

MR. MEEHAN: Have you ever tried the experiment of having more females in the pond than just exact pairs?

MR. KOPPLIN: No, we always tried to pair them off as nearly as possible.

MR. MEEHAN: You have tried, say, three to two?

MR. KOPPLIN: No.

MR. MEEHAN: You think they all paired up?

MR. KOPPLIN: Well, no, they did not; I saw quite a few loafers.

MR. R. S. JOHNSON, Washington, D. C.: I would like to ask if the bass distributed were counted or estimated?

MR. KOPPLIN: They were counted. Any one visiting those lakes in the spring would have an idea about the number of young fish.

MR. C. W. WILLARD, Westerly, R. I.: I would like to ask if you make any attempt at artificial feeding?

MR. KOPPLIN: No, except in the smaller ponds. We tried it year after year and cut up a lot of crayfish, lungs, etc., but in our 60 acres of water there is about enough natural food so we get along without artificial food.

MR. MEEHAN: What food have you in those lakes outside of crayfish, daphnia, cyclops, etc.?

MR. KOPPLIN: The water is alive with all kinds of insects.

MR. MEEHAN: Do you see swimming in there a small, crab-like creature, very minute?

MR. KOPPLIN: Myriads of them.

MR. MEEHAN: That is the secret of your success, is it not?

MR. KOPPLIN: For a long time I doubted whether or not they were young bass, but they were much smaller. In my early experience the water was muddy, and it was hard to determine.

MR. WORTH: Does the President refer to the fresh-water flea in his question?

MR. MEEHAN: I refer to the daphnia.

MR. KOPPLIN: We have experts from the Washington University, and I depend on them in these technical matters. I know my fish well and their technical names, but I am not very familiar with the various forms of insects, or at least their technical names.

MR. MEEHAN: Those of us who have been specially interested in bass culture and have had to struggle a great deal have been very much interested in this work.

MR. W. T. THOMPSON, Fairport, Iowa: Mr. Worth referred to the probability that the goldfish would spawn during the season and furnish a great deal of food, and I would like to ask if such is the case. Also reference has been made to the shore line, and I would like to ask whether the bulk of the pond area was not shallow and only occasionally deep. I judge the pond was 6 or 7 feet deep at the maximum, but wondered whether the greater portion was not shallow.

MR. KOPPLIN: It is 6 feet in the centre going to a feather-edge.

MR. WORTH: I would like to ask the gentleman to tell the meeting how the spawning sod is put down. He uses cut sod for the spawning bed for the large-mouth black bass. How far apart and how near the shore are the beds placed?

MR. KOPPLIN: For years we used nothing but gravel until we found fish spawning on willow roots, preferable to sand, and that they would work down to solid clay. We have been using goldfish for years for food. There has been an unusual growth of goldfish this year. Ordinarily we do not get so many goldfish, as they are devoured, but they got a good start this year. The goldfish spawned on the sod in about a foot of water, and I noticed bass took possession of this sod; so I

have been using the sod very extensively for bass nests, placing them 15 feet apart in 12 to 18 inches of water.

MR. G. W. N. BROWN, Homer, Minn.: In how large pieces?

MR. KOPPLIN: About the size of an ordinary chair bottom.

MR. BROWN: Of what thickness?

MR. KOPPLIN: About 3 inches.

MR. BROWN: Do you leave the grass side of the sod up?

MR. KOPPLIN: The grass is not long—only about 1 inch to 2 inches high. The bass are constantly working over there sweeping the sediment off the surface.

MR. MEEHAN: Don't you think that after the young bass have started to grow, if you made an examination of the sod early in the morning you would find young fish feeding on the eggs of the goldfish, or wherever they deposited their eggs, thus furnishing a lot of food for the little bass?

MR. KOPPLIN: Yes.

MR. WILLARD: Have you noticed particularly whether your little bass feed more generally upon the spawn of the goldfish, or do they feed upon the little goldfish? Have you seen them feed on the very minute goldfish?

MR. KOPPLIN: Yes.

MR. WILLARD: Don't the little bass catch them?

MR. KOPPLIN: Yes. I notice that the goldfish are hot after their own eggs; but I have not noticed the bass.

MR. BUCK: Have you had any trouble with the adult goldfish eating the eggs of the bass?

MR. KOPPLIN: The poor goldfish are scared—they are afraid of the bass and do not eat their eggs.

MR. WORTH: About that matter of the algæ, I would like to understand what plant it is—while Dr. Forbes and Dr. Bean are here, who actually know what such things are. From Dr. Hugh M. Smith's excellent book, on the Japanese Goldfish, I derived the idea that the algæ were very many very small floating plants, so small that they were microscopic and constituted the food of crustaceans which are in themselves sufficiently small to comprise the food of black bass fry. But now it seems they are speaking of a massive growth that is floating on the surface of the water, that is in strands, in threads, green like a plant, and called frog spittle.

MR. KOPPLIN: That is it.

MR. WORTH: What is the scientific name of that frog spittle?

DR. FORBES: There are a great many species of what are called filamentous algæ. The various species of *Spirogyra* are such forms; but there is often a great mixture of species in a single film or sheet of algæ on the surface of a pool. Some consist of single separate cells; but the threadlike algæ are composed of a series of cells joined end to end. They form by their interlacing a web composed of long threads and strands, among which single minute cells and a variety of other

forms may be entangled. They all come under the general name of algæ, which is a botanical name, however, rather than a practical one.

MR. WORTH: I will ask Mr. Kopplin whether those goldfish this summer destroyed any of the bottom growth of plants in the ponds, or whether it was the surface plants alone?

MR. KOPPLIN: The surface plants. Our lakes can be drained well, and that would get rid of the moss in the fall of the year. In raising carp I would go to Illinois and get algæ starting from the bottom. It settles down on the bottom of the pond in the winter and comes up again in the spring. It got such a start one year that I could not work with my bass; so I put about 50 or 60 carp in one pond where they spawned. Thousands of little carp resulted and they killed off the moss.

DR. BARTLETT: They are good for something then.

MR. MEEHAN: What is that moss you are speaking of?

DR. FORBES: Not the chara. We have almost none in this state. Probably it is one of the milfoils.

MR. KOPPLIN: It is the stuff you cannot get through with a boat.

PROFESSOR DYCHE: You put the carp in with the young bass?

MR. KOPPLIN: No, in with the adult bass in the spring.

PROFESSOR DYCHE: It is stated that in four days after a certain number of goldfish were put in there certain forms of fresh water algæ disappeared. It is not probable that goldfish in four days would destroy such algæ, especially where there is a mass of the material all through the ponds, as we understand it. As a matter of fact the fresh water algæ, and particularly the species of *Spirogyra*, disappear sometimes in a week's time without goldfish. After the plant once has its growth and development it sometimes rapidly disappears. We have noticed that in our ponds. There is such a vast number of things connected with the relationship of plant life and fish life in any pond, that I have deemed it wise to get the consent of the Kansas Legislature and Board of Regents of the University of Kansas to study this subject. Since we have been put in charge of the Kansas State fish hatchery we have undertaken to found a fish hatchery based primarily on the food habits of fish. In this line there seem to be many problems that are unsolved. We have gotten together the best information regarding bass culture that it was possible to get from the reports of this Society, and with all due deference to all the gentlemen who have written on the subject of black bass, after you have summed it up there seems to be considerable that is not known, particularly with regard to what young bass eat.

In regard to insects in the pond, many of them look very good, but they are not eaten by the fish at all. The only way we can find out what the fish eat and do is to study the habits of the fish. We have opened the stomachs of several thousand fish and studied them. We have studied the stomachs of between 1,100 and 1,200 German carp and we have on hand 2,700 stomachs taken in May and June, to work up;

however, having your nose in carp entrails continuously for hours to determine contents of stomachs and intestines is not the most pleasant work. We are planning to put up a building to be used as a laboratory for the state fish hatchery, for the purpose of studying plants, insects, and fish and their relationships. You will all be welcome to come to the Kansas State hatchery and work when this building is constructed. The building will be primarily for the students of the University of Kansas, but students from other universities and colleges will be welcomed to carry on certain investigations which should be carried on to clear up a considerable number of problems connected with fish culture, and particularly the black bass, perhaps the best known and most highly prized fish in the interior part of the country.

In my paper I will refer to the fact that we are building 83 new ponds for the special purpose of raising black bass, crappie, blue gills, sunfish and catfish; but we raise many of them in the same pond; and we may say also that many of these ponds are intended for black bass. The subject of plant life in its relation to insect life, and plant life and insect life in relation to fish life, particularly young fish life, is a subject upon which it seems very hard to get any definite information. We hope with a laboratory for such investigations that something may be found out about fishes, especially the young fishes, that will be a little more definite; and when we come to stock a pond with fish it will also be stocked with the proper plants. This will enable the ponds to be managed so that the plant life will aid the fish life. This is one of the ideas we hope to carry out in the development of this new hatchery.

MR. WORTH: Before we leave this question of the bass I want to say that this matter of the plant growth in bass ponds is a very serious one. There are some ponds which can be drawn in the winter time to freeze this moss out. Even then it is only partially killed. But at stations where the water is scarce, they cannot afford to draw ponds down every time they want to get the moss out; and during the winter season with fish contained in ponds, the water cannot be drawn off for freezing purposes.

Our moss this year had to be removed. The usual method was to take a flat-bottomed boat or skiff and use rakes, but this was laborious and expensive and cost altogether too much. Then I undertook to cut the moss out from the shore, and used barbed wire made fast to small rope, dropped it on the bottom and sawed back and forth. In this way we cut out a good deal of the moss, but not all. Then I put chains on the barbed wire and found that they went down into the soft mud and cut underneath the plants, and after all we had to go over the ponds with rakes. Then I thought to obtain discarded hand saws which I riveted together, making something that would have the weight to keep it on the bottom and still have the breadth to prevent it from going into the mud, so that it would cut the plants off at the bottom, like cutting down hay. I did not apply the band saw idea; but in discussing it with others whom I thought would take an interest I learned that there is a

saw of the kind already made, and that it is on sale somewhere; it has teeth on but one side, and in order to make a doubled-edged saw it is turned over, while hot, every six inches.

MR. FEARING: A man named Ziemsen advertises it in the *London Fishing Gazette*.

MR. MEEHAN: There was an exhibition of a machine similar to that at the Toledo meeting in 1909. The demonstration was made in an artificial stream at the Castalia Club. It was quite successful. I have sympathized a great deal with Mr. Worth because the method he pursued in raking and hauling is what we have had to do ourselves, to keep our ponds clear of the chara moss.

MR. BROWN: I would like to ask Dr. Bean if this *Simulium* must have rippling water, or a current in which to propagate, as Dr. Forbes mentioned?

DR. BEAN: No, it propagates in the pond, which is the ordinary pond with an inflow and outflow. It is true there is a good flow of water through it, but it does not make ripples on the surface. We have put nothing in to cause ripples, and yet in the ordinary bass and crappie ponds this *Simulium* develops in enormous numbers.

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'08 JONES, THOS. S., Louisville, Ky.
'10 JORDAN, DR. DAVID STARR, Stanford University, Cal.
'02 JOSLYN, C. D., Ford Building, Detroit, Mich.
- '05 KEESECKER, A. G., U. S. Bureau of Fisheries, Erwin,
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'99 KEIL, W. M., Tuxedo Park, N. Y.
'08 KELLOGG, PROF. JAMES L., Williams College, Williams-
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'02 KENDALL, DR. WILLIAM C., U. S. Bureau of Fisheries,
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'04 KENT, EDWIN C., Tuxedo Club, Tuxedo Park, N. Y.
'00 KENYON, A. W., Usquepaugh, R. I.
'10 KILBORN, JOHN R., Cape Vincent, N. Y.
'08 KILPATRICK, CHAS. M., Station F, Minneapolis, Minn.
'08 KINCAID, W. S., Denver, Colo.
'04 KISTERBOCK, JOSIAH, JR., Aldine Hotel, Philadelphia,
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'04 KITTREDGE, BENJAMIN R., Carmel, N. Y.
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'10 KOPPLIN, PHILIP, JR., Missouri Fish Commission,
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'03 LAMBSON, G. H., U. S. Bureau of Fisheries, Baird, Cal.
'11 LAND, S. E., Department of Game and Fish, Denver,
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'08 LAY, CHARLES, Sandusky, Ohio.

- '98 LEACH, G. C., U. S. Bureau of Fisheries, Afognak, Alaska.
- '10 LEE, W. McDONALD, Commissioner of Fisheries, Irvington, Va.
- '09 LEIS, HERMAN, Melvina, Wis.
- '10 LEMBKEY, WALTER I., U. S. Bureau of Fisheries, Washington, D. C.
- '02 LEWIS, CHARLES E., Chamber of Commerce, Minneapolis, Minn.
- '08 LIBBY, T. E., Vinal Haven, Me.
- '10 LINTON, DR. EDWIN, Washington & Jefferson College, Washington, Pa.
- '06 LOCHER, WM., Kalamazoo, Mich.
- '00 LOCKE, E. F., U. S. Bureau of Fisheries, Woods Hole, Mass.
- '98 LYDELL, DWIGHT, Michigan Fish Commission, Comstock Park, Mich.
- '10 LYDELL, MRS. DWIGHT, Comstock Park, Mich.
- '10 MABIE, CHARLES H., Maywood, N. J.
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- '98 MARKS, J. P., Michigan Fish Commission, Paris, Mich.
- '99 MARSH, M. C., U. S. Bureau of Fisheries, Washington, D. C.
- '06 MARTY, JOHN M., Minnesota Fish and Game Association, St. Paul, Minn.
- '00 MATHEWSON, G. T., President State Commission of Fisheries and Game, Thompsonville, Conn.
- '10 MAXWELL, HENRY V., Butler, Tenn.

- '84 MAY, W. L., 314 Nassau Block, Denver, Colo.
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'11 MILES, GEO. W., State Commissioner of Fisheries and Game, Indianapolis, Ind.
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'08 MILLER, FRANK M., President Board of Commissioners for the Protection of Birds, Game and Fish, 605 Maison Blanche Building, New Orleans, La.
'10 MILLETT, ARTHUR L., Gloucester, Mass.
'00 MILLIGAN, DR. J. D., Woods Hole, Mass.
'92 MILLS, G. T., Chairman State Fish Commission, Carson City, Nev.
'11 MINCH, HARRY C., U. S. Bureau of Fisheries, Fairport, Iowa.

- '10 MINER, PROF. ROY W., American Museum of Natural History, New York City.
- '07 MITCHELL, HUGH C., U. S. Bureau of Fisheries, Baird, Cal.
- '10 MITCHELL, WALTER J., Chairman Maryland Shell Fish Commission, La Plata, Md.
- '99 MOORE, CHARLES H., care Michigan Fish Commission, Detroit, Mich.
- '04 MOORE, DR. H. F., U. S. Bureau of Fisheries, Washington, D. C.
- '05 MORCHER, GEORGE, London, Ohio.
- '07 MORGAN, C. W., N. Y. Aquarium, New York City.
- '10 MORGAN, WM. E., U. S. Bureau of Fisheries, Edenton, N. C.
- '10 MORGAREIDGE, C. W., Story, Wyo.
- '92 MORRELL, DANIEL, Hartford, Conn.
- '10 MORRILL, J. P., Verdi, Nev.
- '04 MORRIS, DR. ROBERT T., 616 Madison, Ave., New York City.
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- '08 MOWBRAY, LOUIS L., Director Bermuda Aquarium, Hamilton, Bermuda.
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- '04 NEAL, L. J., Michigan Fish Commission, Comstock Park, Mich.
- '73 and '10 NEIDLINGER, PHILIP, 2225 Emmons Ave., Sheepshead Bay, N. Y.

- '08 NESLEY, CHARLES H., Pottstown, Pa.
'86 NEVIN, JAMES, Superintendent Wisconsin Fish Commission, Madison, Wis.
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- '97 O'BRIEN, W. J., Supt. of Hatcheries, Nebraska Game and Fish Commission, Gretna, Nebr.
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'10 OWEN, THOS. H., Muskogee, Okla.
- '10 PAIGE, CHARLES L., Shasta, Cal.
'04 PALMER, DR. THEODORE S., United States Department of Agriculture, Washington, D. C.
'01 PARKER, W. H., Lac La Pêche, Quebec, Canada.
'04 PARKHURST, HON. C. FRANK, Providence, R. I.
'07 PATCHING, FRED, Loring, Alaska.
'11 PATRICK, W. E., Supt. of State Fish Hatcheries, Denver, Colo.
'02 PAXTON, THOMAS B., Board of State Fish and Game Commissioners, Cincinnati, Ohio.
'06 PAYNE, CHARLES, Wichita, Kan.

- '11 PELL, GEO. W., 520 16th St., Denver, Colo.
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'10 PERCE, H. WHEELER, 1033 Hearst Bldg., Chicago, Ill.
'10 PEW, JOHN J., Gloucester, Mass.
'09 PFLEUGER, J. E., Akron, Ohio.
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'09 PONDER, AMOS L., New Orleans, La.
'04 POPE, T. E. B., U. S. Bureau of Fisheries, Washing-
ton, D. C.
'06 PORTER, RICHARD, Board of State Fish Commissioners,
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'09 POSTAL, FRED., State Board of Fish Commissioners,
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'09 POWER, D. H., President State Board of Fish Commis-
sioners, Suttons Bay, Mich.
'10 POWER, MRS. D. H., Suttons Bay, Mich.
'08 PRATT, DR. JOSEPH HYDE, State Geologist, Chapel
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'05 PRICE, ANDREW, Marlinton, W. Va.
'04 PRICE, CALVIN W., Marlinton, W. Va.
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'03 RACE, E. E., U. S. Bureau of Fisheries, Green Lake,
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'10 RADCLIFFE, LEWIS, U. S. Bureau of Fisheries, Beau-
fort, N. C.
'03 RANDALL, G. W., Plymouth, Mass.
'05 RANKIN, J. F., South Charleston, Ohio.
'84 RATHBUN, DR. RICHARD, Assistant Secretary Smith-
sonian Institution, Washington, D. C.

- '93 RAVENEL, W. DE C., U. S. National Museum, Washington, D. C.
- '03 REED, C. A., Fish and Game Warden, Santa Cruz, Cal.
- '09 REED, DR. H. D., Cornell University, Ithaca, N. Y.
- '93 REIGHARD, PROF. JACOB E., University of Michigan, Ann Arbor, Mich.
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- '10 RIDER, H. A., Executive Agent Minnesota Game and Fish Commission, St. Paul, Minn.
- '10 RING, E. E., Orono, Me.
- '03 RIPPEL, ROBERT, Bayfield, Wis.
- '99 ROBERTS, A. D., Auditor Inland Fisheries Commission, Woonsocket, R. I.
- '10 ROBERTS, B. H., 1413 New York Ave., Washington, D. C.
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- '99 ROOT, HENRY T., Harbor Commission, State House, Providence, R. I.
- '10 ROQUEMORE, C. H., Montgomery, Ala.
- '98 ROSENBERG, ALBERT, Kalamazoo, Mich.
- '11 ROTE, E. E., U. S. Bureau of Fisheries, Homer, Minn.
- '10 ROWE, HENRY C., Groton, Conn.
- '11 RUCKMAN, CHAS. W., U. S. Bureau of Fisheries, Homer, Minn.
- '09 RUNION, H. P., Bankleman, Nebr.
- '97 RUSSEL, HENRY, Michigan Central R. R., Detroit, Mich.

- *'05 SAFFORD, W. H., Missouri Fish Commission, St. Joseph, Mo.
- '05 SALMON, ALDEN, South Norwalk, Conn.
- '07 SAMSON, JAMES B., 320 Lewis Building, Pittsburgh, Pa.
- '02 SAUNDERS, DR. H. G., Chattanooga, Tenn.
- '10 SAUNDERS, H. P., Roswell, New Mexico.
- '08 SAUNDERS, J. P., Deerwood, Minn.
- '10 SCHMAUSS, LEONARD W., U. S. Bureau of Fisheries, Leadville, Colo.
- '11 SCHMITT, WALDO, U. S. Bureau of Fisheries, Washington, D. C.
- '10 SCHNOOR, JACOB, Belford, N. J.
- '00 SEAGLE, GEORGE A., U. S. Bureau of Fisheries, Wytheville, Va.
- '10 SEAL, WM. P., Delair, N. J.
- '00 SELLERS, M. G., 1306 Arch Street, Philadelphia, Pa.
- '10 SHEBLEY, FRANK A., Superintendent Santa Cruz County Hatchery, Brookdale, Cal.
- '91 SHERWIN, H. A., 100 Canal Street, Cleveland, Ohio.
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- '11 SHINN, JAMES A., Department of Game and Fish, Denver, Colo.
- '11 SHIRA, AUSTIN F., U. S. Bureau of Fisheries, Homer, Minn.
- '08 SHIRAS, GEO., 3d, Stoneleigh Court, Washington, D. C.
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- '03 SHURTLEFF, MERRILL, Lancaster, N. H.
- '10 SIEURIN, P. G., Director Central Swedish Fish Hatchery Co., Kloten, Sweden.
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- '91 SMITH, DR. HUGH M., U. S. Deputy Commissioner of
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- '10 SMITH, IRVING EDWARD, 1532 16th St. N.W., Wash-
ington, D. C.
- '99 SMITH, LEWIS H., Algona, Iowa.
- '08 SMITH, RICHARD, Waukegan, Ill.
- '05 SNYDER, J. P., U. S. Bureau of Fisheries, Bozeman,
Mont.
- '11 SOUTHALL, JOHN B., U. S. Bureau of Fisheries, Fair-
port, Iowa.
- '99 SOUTHWICK, J. M. K., Newport, R. I.
- '08 SPEAKS, JOHN C., Chief Warden Ohio Fish and Game
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- '87 SPENSLEY, CALVERT, Mineral Point, Wis.
- '10 STACK, F. GEORGE, Sabattis, N. Y.
- '07 STANTON, W. C., International Falls, Minn.
- '04 STAPLETON, M. F., U. S. Bureau of Fisheries, Man-
chester, Iowa.
- '00 STARR, W. J., State Board of Fish Commissioners, Eau
Claire, Wis.
- '10 STEAD, DAVID G., Fisheries Department, Sydney, New
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- '11 STERETT, W. G., State Game, Fish and Oyster Com-
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- '03 STEELE, G. F., Port Edwards, Wis.
- '03 STEVENS, ARTHUR F., 227 West Grand St., Elizabeth,
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- '05 STEVENSON, CHARLES H., 511 Moffat Building, De-
troit, Mich.
- '08 STILES, ROBT., U. S. Bureau of Fisheries, Bozeman,
Mont.
- '08 STONE, J. W., 921 University Ave., Madison, Wis.
- '04 STORY, JOHN A., U. S. Bureau of Fisheries, Green
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- '04 STOTZ, MARTIN, 1132 Land Title Building, Philadelphia, Pa.
- '98 STRANAHAN, F. A., Cleveland, Ohio.
- '88 STRANAHAN, J. J., Bullochville, Ga.
- '04 SUMNER, DR. FRANCIS B., U. S. Bureau of Fisheries, Washington, D. C.
- '04 SURBER, THADDEUS, U. S. Bureau of Fisheries, Fairport, Iowa.
- '11 SWIFT, H. F., 307 Crocker Building, San Francisco, Cal.
- '10 SWORD, C. B., New Westminster, British Columbia, Canada.
- '97 SYKES, HENRY, Wisconsin Fish Commission, Bayfield, Wis.
- '10 SYLVESTER, RICHARD, Municipal Building, Washington, D. C.
- '04 TALBOTT, HENRY, Interstate Commerce Commission, Washington, D. C.
- '03 TEAL, J. N., Worcester Block, Portland, Ore.
- '99 THAYER, W. W., U. S. Bureau of Fisheries, Northville, Mich.
- '06 THOMAS, W. H., U. S. Bureau of Fisheries, Fairport, Iowa.
- '05 THOMPSON, GEORGE B., Davis, W. Va.
- '05 THOMPSON, JAMES F., Martinsburg, W. Va.
- '00 THOMPSON, W. P., 112 Broad Street, Philadelphia, Pa.
- '00 THOMPSON, W. T., U. S. Bureau of Fisheries, Bozeman, Mont.
- '08 THOMSON, G. H., Estes Park, Colo.
- '10 TIERNEY, JAS. N., Roxbury, Vt.
- '92 TITCOMB, JOHN W., Commissioner of Fisheries and Game, Lyndonville, Vt.
- '11 TONGUE, LEONARD M., U. S. Bureau of Fisheries, Washington, D. C.
- *'01 TOWNSEND, DR. CHARLES H., Director New York Aquarium, New York City.

- '99 TUBBS, FRANK A., U. S. Bureau of Fisheries, Neosho, Mo.
- '98 TULIAN, EUGENE A., care Board for the Protection of Birds, Game and Fish, New Orleans, La.
- *'11 VALETTE, LUCIANO H., Chief of Section of Fish Culture, 827 Rivadavia, Buenos Aires, Argentina.
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- '10 VILES, BLAINE S., Inland Fish and Game Commissioner, Augusta, Me.
- '00 VINCENT, W. S., U. S. Bureau of Fisheries, Tupelo, Miss.
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- '96 WALKER, BRYANT, Detroit, Mich.
- '11 WALKER, DR. H. T., 210 Main St., Denison, Texas.
- '08 WALLACE, JOHN H., JR., Commissioner Department of Game and Fish, Montgomery, Ala.
- '03 WALLICH, CLAUDIUS, U. S. Bureau of Fisheries, Concrete, Wash.
- '96 WALTERS, C. H., Cold Spring Harbor, N. Y.
- '98 WARD, PROF. H. B., University of Illinois, Urbana, Ill.
- '03 WATERHOUSE, REV. E. M., Broadway and 71st St., New York City.
- '08 WEBB, W. M., State Shellfish Commissioner, Morehead City, N. C.
- '92 WEBB, W. SEWARD, 44th St. and Vanderbilt Ave., New York City.

- '07 WEBSTER, B. O., Wisconsin Fish Commission, Madison, Wis.
- '08 WEBSTER, H. A., Oregon City, Ore.
- '01 WENTWORTH, E. E., U. S. Bureau of Fisheries, Concrete, Wash.
- '08 WESSEL, JOSEPH A., Secretary Board of Game and Fish Commissioners, Crookston, Minn.
- '01 WHEELER, CHARLES STETSON, Union Trust Building, San Francisco, Cal.
- '06 WHIPPLE, JAS. S., Albany, N. Y.
- '02 WHISH, JOHN D., Albany, N. Y.
- '04 WHITAKER, ANDREW R., State Fishery Commission, Phoenixville, Pa.
- '96 WHITE, R. TYSON, 320 Bridge Street, Brooklyn, N. Y.
- '10 WHITMAN, EDWARD C., Canso, Nova Scotia, Canada.
- '11 WIDMYER, EDGAR R., U. S. Bureau of Fisheries, Homer, Minn.
- '89 WILBUR, H. O., 235 Third St., Philadelphia, Pa.
- '99 WILLARD, CHARLES W., President Inland Fisheries Commission, Westerly, R. I.
- '01 WILSON, C. H., Glens Falls, N. Y.
- '11 WILSON, J. S. P. H., Chairman, Board of Inland Game and Fish Commissioners, Auburn, Me.
- '10 WINCHESTER, GRANT E., Forest, Fish and Game Commission, Bemus Point, N. Y.
- '00 WINN, DENNIS, U. S. Bureau of Fisheries, Oregon City, Ore.
- '99 WIRES, S. P., U. S. Bureau of Fisheries, Duluth, Minn.
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- '97 WOOD, C. C., Plymouth, Mass.
- '11 WORTH, HENRY B., U. S. Bureau of Fisheries, Washington, D. C.
- '84 WORTH, S. G., U. S. Bureau of Fisheries, Mammoth Spring, Ark.
- '10 WURZBURG, L., Ketchikan, Alaska.

- '09 YERINGTON, EDWARD B., Board of State Fish Commissioners, Carson City, Nev.
'10 YOUNG, CAPT. CARL C., 2 Mt. Vernon St., Gloucester, Mass.
'06 YOUNG, CAPT. JOHN L., Atlantic City, N. J.
'99 ZALSMAN, P. G., Wisconsin Fish Commission, Wild Rose, Wis.

Recapitulation

HONORARY	76
CORRESPONDING	19
ACTIVE (including life members)	543
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TOTAL MEMBERSHIP	638

CONSTITUTION

(As amended to date)

ARTICLE I

NAME AND OBJECT

The name of this Society shall be American Fisheries Society. Its object shall be to promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; the uniting and encouraging of all interests of fish culture and the fisheries, and the treatment of all questions regarding fish, of a scientific and economic character.

ARTICLE II

MEMBERS

Any person shall, upon a two-thirds vote and the payment of two dollars, become a member of this Society. In case members do not pay their fees, which shall be two dollars per year after the first year, and are delinquent for two years, they shall be notified by the treasurer, and if the amount due is not paid within a month thereafter; they shall be, without further notice, dropped from the roll of membership. Any person can be made an honorary or a corresponding member upon a two-thirds vote of the members present at any regular meeting.

The President (by name) of the United States and the Governors (by name) of the several States shall be honorary members of the Society.

Any person shall, upon a two-thirds vote and the payment of twenty-five dollars, become a life member of this Society, and shall thereafter be exempt from all annual dues.

ARTICLE III

OFFICERS

The officers of this Society shall be a president and a vice-president, who shall be ineligible for election to the same office until a year after the expiration of their term; a corresponding secretary, a recording secretary, an assistant recording secretary, a treasurer, and an executive committee of seven, which, with the officers before named, shall form a council and transact such business as may be necessary when the Society is not in session—four to constitute a quorum.

In addition to the officers above named there shall be elected annually five vice-presidents who shall be in charge of the following five divisions or sections:

1. Fish culture.
2. Commercial fishing.
3. Aquatic biology and physics.
4. Angling.
5. Protection and legislation.

ARTICLE IV

MEETINGS

The regular meeting of the Society shall be held once a year, the time and place being decided upon at the previous meeting, or, in default of such action, by the executive committee.

ARTICLE V

ORDER OF BUSINESS

1. Call to order by president.
2. Roll call of members.
3. Applications for membership.
4. Reports of officers.
 - a. President.
 - b. Secretary.
 - c. Treasurer.
 - d. Vice-Presidents of Divisions.
 - e. Standing committees.

5. Committees appointed by the president.
 - a. Committee of five on nomination of officers for ensuing year.
 - b. Committee of three on time and place of next meeting.
 - c. Auditing committee of three.
 - d. Committee of three on program.
 - e. Committee of three on publication.
 - f. Committee of three on publicity.
6. Reading of papers and discussion of same.
(Note—In the reading of papers preference shall be given to the members present.)
7. Miscellaneous business.
8. Adjournment.

ARTICLE VI

CHANGING THE CONSTITUTION

The constitution of the Society may be amended, altered or repealed by a two-thirds vote of the members present at any regular meeting, provided at least fifteen members are present at said regular meeting.

